ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

VOL. XLIII. No. 6.

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NEW YORK UNDERGROUND RAPID TRANSIT RAILway affairs are still in an unsettled condition. The contractor, Mr. John B. McDonald, whose difficulty with the security companies in the matter of bonds was briefly noted in our last issue, has discontinued negotiations with them, and, on Feb. 6, asked and received from the Rapid Transit Commission a further extension of time to arrange for bonds elsewhere. Mr. McDonald's formal application for further time explains briefly the reasons which have caused the delay, as follows:

> Circumstances have made it necessary for me to apply to your honorable body for a further extension of time in which to furnish the securities required by the contract to construct and operate the rapid transit railroad. When I made my bid I had what I believed to be satisfactory assurances that they (the three surety companies named in the bid) would go on my bond in case the contract was awarded to me. But when, after the award, I renewed my application to them, I found them disposed to impose conditions which were unexpected and much more onerous than I had anticipated when I named them as sureties in my proposal. Negotiations lasting over ten days resulted in the statement of the companies of requirements which I deemed unreasonable, and with which, on short notice, I was not prepared to comply. They were finally unwilling to execute the sureties unless cash or its equivalent representing the full amount of their bonds was practically set apart for them. On the 31st instant I notified the companies that it was useless to continue negotiations on those lines, and since that time I have been planning to substitute other sureties in their place and stead. I feel reasonably certain of providing such substitutes within a reasonable time, providing that the commission will grant me a further extension of — days.

Upon the showing made by this letter and Mr. McDonald's verbal evidence, the Rapid Transit Commission, on Feb. 6, extended the time within which he should qualify until Feb. 20. It, at the same time, formally rejected the bid of Mr. Andrew Onderdonk, the only other bidder for the work, and ordered his guarantee check of $150,000 to be returned. It is stated that Mr. McDonald's present plans include the formation of a construction company, whose capital stock, paid up in cash, shall be a part of the security given for Mr. McDonald, and its bonds, and, perhaps, the individual signatures of stockholders, will make up the rest. It is proposed that even his continuing bond of $1,000,000 shall be represented by part cash or securities and the $5,000,000 construction bond will be represented by perhaps half cash or securities. If any question should arise as to the sufficiency of the security offered, as contemplated by the Appellate Division of the Supreme Court, an application will be made to that court to pass upon it, and it is understood that the members of the court are in full accord with the commission. The financial details of the arrangement are entirely in the hands of August Belmont & Co. The bill to amend the original Rapid Transit Act so that the City Comptroller may issue the bonds for construction without the concurrence of the New York Municipal Assembly has been signed by the Mayor of New York city and is now in the hands of the Governor for signature, when it will become a law. Since the above was put in type Mr. McDonald and August Belmont & Co. have submitted a list of the securities by which they propose to secure the bond required by the Rapid Transit Commission, and it is stated that the latter body has signified its satisfaction with them. It now seems reasonably certain that Mr. McDonald will formally qualify for the contract before Feb. 20.

A STATE BRIDGE AND TUNNEL COMMISSION to assume charge of the building of bridges and tunnels across the East River at New York city is proposed in a bill which Mr. Edward Brennan has introduced in the New York State Assembly. This bill authorizes a state commission, appointed under its provisions, to construct two bridges over the East River, and a tunnel under the same stream from the Battery to South Brooklyn, and also a tunnel from South Brooklyn to Staten Island. The first bridge is to be located between the present Brooklyn Bridge and the New East River Bridge, and the second between the latter structure and Blackwell's Island. The bill provides that the city of New York shall turn over to the commission all the maps, plans, and everything relating to the bridges and tunnels across the East River which it has. The city is to bear the entire cost of construction. The commission is to consist of six members, to be non-partisan in character, and is to be appointed by the Governor. The effect of the bill is to remove from the hands of the New York city officials all control over the new East River bridges which they now have under way, and it is certain that it will be vigorously opposed by the New York city representatives in the State Assembly.

COMPETITIVE PLANS for the Memorial Bridge across the Potomac River at Washington, D. C., have been submitted by Geo. S. Morison, Leffert L. Buck, Wm. H. Burr and Wm. R. Hutton, Mems. Am. Soc. C. E., and the Secretary of War has appointed a commission of engineers to examine them and select a plan to be adopted in constructing the bridge. The commission consists of the following persons: Lieut.-Col. Chas. J. Allen, Maj. T. W. Symons, Capt. David Du B. Gaillard, Corps of Engineers, U. S. A., and Stanford White and James G. Hill, architects. The bridge is designed to be a memorial to American patriotism and is intended to cost from $1,000,000 to $2,000,000.

A DOUBLE-DECK FREIGHT TERMINAL has been established at Manchester, England, by the Great Northern Ry. It is approached by a four-track line, and on the main level there are ten tracks, six of these (in pairs) extending into the building between long platforms. On each side of the yard is an incline track leading to the low-level yard or basement, which has five tracks, all connected by switches. At each end of the basement is a track at right angles with the yard tracks, intersecting them and connected with them by means of turntables. A three-story warehouse building is above the freight station proper. The terminal has accommodation on the upper level for 48 small English cars inside, and 257 cars in the yard, while on the low level there is accommodation for 56 wagons inside the shed and 74 in the yard. The roadways give room for 40 carts or wagons on the upper level and 100 on the lower level, with stabling for 130 horses under the inclined tracks. There are 17 hydraulic cranes of 3,000 lbs. capacity on the high level, and 11 on the low level, with three of 5,000 lbs. on the lower level and two of 10 and 25 tons in the yards.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred at Edwardsburg, Mich., on Jan. 27. The boiler of a locomotive on the tracks of the Chicago & Grand Trunk R. R. exploded, killing three men.

THE "BOURGOGNE" DISASTER of July 4, 1898, has been ruled upon by the highest French court, and the Compagnie Generale Transatlantique, the owner of the ship, has been exonerated from all responsibility. The case passed upon was that of the Widow Resel, who sued for $40,000 for the loss of her husband; and a lower court awarded her $20,000; this latter decision is reversed by the higher court. The court finds that Captain Deloucle was in his proper course and the ship was running at about 12 knots; the life-saving apparatus was in order, and the doors in the water-tight bulkheads were closed; the owners of the ship committed no default, and the company was not responsible for the conduct of a few Austrian deck passengers who took forcible possession of the boats.

THE FRENCH NAVAL PROGRAM involves an expenditure of $100,000,000 in reorganizing the navy, which seems to be in a bad way, according to the report of their own experts. The development of submarine torpedo boats is especially urged as a defence against attack by the British navy.

THE SHEATHING OF WARSHIPS has been voted against by the Board on Construction. It was shown that the expensive wood and copper sheathing put upon the "Chesapeake" was not only a failure, but menaced the life of the metal. The practice has been abandoned in England, after a fair trial. The copper does not prevent fouling; and it is believed that some kind of paint, or substitute for paint, will better protect the bottom of the ship.

THE GREAT LAKES ORE-CARRYING FLEET for 1900 will contain several vessels of unusual size, which are now being built at the different Great Lake shipyards. Two of these vessels being built for the American Steel & Wire Co. will each be 500 ft. long, 52 ft. beam and 30 ft. deep. When loaded on an 18½-ft. draft each of these boats is expected to carry 8,000 gross tons, or about 9,000 tons net. At the present time the record for the greatest ore cargo is held by the Minnesota Steamship Co.'s barge "Manila," which, during the past season, took a cargo of 8,376 net tons from Two-Harbors, Mich., to South Chicago, Ill. The same company's steamer "Malietoa" carried between the same ports a cargo of 8,215 net tons, and the Rockefeller tow barge "John Smeaton" has a record of 8,339 net tons. It is expected that the new steamers will surpass these records during 1900. The vessels for ore traffic now being built at the Great Lake shipyards, is given by Mr. Waldon Fawcett in the "American Manufacturer" for Feb. 1, 1900, as follows:

> At the yard of the Chicago Ship Building Co. there are building three steamers and three barges. Two of the steamers are for the Carnegie interests and one for John D. Rockefeller. Two of the barges are for the Minnesota Steamship Co. and one for the Carnegie line. All of these vessels are of the largest class. The Detroit Ship Building Co., of Detroit, will deliver for the ore trade the steamer "Admiral," building for Alexander McVittie, of Detroit; two steamers of the largest class for Eddy Bros., of Bay City, Mich., and one of the maximum capacity vessels for the Carnegie company. At the Lorain, O., plant of the American Ship Building Co. there are under way two 500-ft. vessels for the American Steel & Wire Co.; two steamers for Carnegie and a 3,000-ton steamer for R. R. Rhodes, of Cleveland. At the Cleveland yard of the same company the uncompleted contracts comprise the steamer "William E. Reis," building for John Mitchell, of Cleveland; a steamer for John D. Rockefeller, and two moderate size vessels for the American Steel & Wire Co. The ship building combine's plant, at West Bay City, Mich., has two more of the big steamers for the American Steel & Wire Co., and the shipyard at the head of the lakes will turn out a large steamer for John D. Rockefeller. The Craig Ship Building Co., Toledo, has a contract from Arthur Hawgood, Cleveland, for one of the steamers with a capacity of 3,000 tons. The other vessels are principally package freighters. The 3,000-ton vessels mentioned are of much lighter draft than the larger boats, and can be used for transporting ore to furnaces which cannot be reached by the big boats. These smaller vessels are of such dimensions as to enable them to pass through the Welland and St. Lawrence canals, and if desired, to ship ore from the Lake Superior country direct to Toronto or Montreal.

AMERICAN MANUFACTURES IN 1899 played a notable part in the foreign commerce of the United States for the year just concluded. According to advance figures furnished by the United States Bureau of Statistics, manufacturers were apparently the busiest people in this busy country of ours in 1899. They increased their importations of materials for use in manufacturing 33% over the year 1898, and actually increased exportations of manufactures nearly 25%, so that the grand total of manufactures exported during the year reaches $380,000,000, and seems likely to touch the $400,000,000 line in the fiscal year which ends June 30, 1900. The exports of manufactures which in 1898 averaged $25,000,000 per month, averaged over $31,000,000 per month in 1899, or more than $1,000,000 for every day in the calendar year. Beginning with $25,806,870 in January, 1899, the figures grew steadily until December showed $35,652,053; December and March of 1899 showing larger exportations of manufactures than those of any preceding month in our history. Not only are the exports of manufactures in 1899 the largest in any year in our history, but they form a larger percentage of our total exports than those of any preceding year, the percentage being for the calendar year 1899, 30.4%; for 1898, 24.9%, and for 1897, 25.9%. The following table shows for 1898 and 1899, the imports and exports of the United States by classes:

	1898.	1899.
Imports.		
Articles of food and live animals	$187,829,802	$229,971,385
Crude condition for domestic industry	190,255,637	267,493,959
Manufactured for use in mechanic arts	59,127,686	75,376,005
Manufactured, ready for consumption	104,804,809	118,339,856
Voluntary use, luxuries, &c.	83,946,514	107,664,366
Total imports	$634,964,448	$798,845,571
Domestic Exports.		
Products of agriculture	$851,915,762	$782,105,048
" of manufactures	307,924,994	380,787,891
" of mining	25,851,092	33,279,187
" of the forest	39,030,313	47,562,121
" of the fisheries	5,819,208	5,637,077
Miscellaneous	3,016,771	3,532,663
Total, domestic exports	$1,233,558,140	$1,252,903,987
Foreign goods re-exported	21,988,126	22,595,684
Total exports	$1,255,546,266	$1,275,499,671
Gold imports	$158,163,952	$51,194,964
Gold exports	16,194,954	45,379,411
Silver imports	29,131,380	30,844,981
Silver exports	53,797,104	53,461,737

A FAST TRAIN RUN OF 628 MILES between Camden Place, Minn., and Harvey, N. Dak., on the Minneapolis, St. Paul & Sault Ste. Marie Ry., was recently made by the regular train No. 108. This train consisted of nine cars hauled by a Schenectady compound locomotive, and it made the run in 12 hrs. 5 mins., with 55 stops, or at the average speed of 52 miles per hour. The tonnage of the train was 349 6 tons. The maximum speed was 67 miles per hour

A NEW TYPE OF EXCAVATING MACHINE.

By S. H. Lea, M. Am. Soc. C. E.*

The demand for the excavation of large quantities of earth from the prism of the Illinois & Mississippi Canal brought into existence various machines for doing the work cheaply and displacing the time-honored method of teams and scrapers. Perhaps the most unique and interesting of these

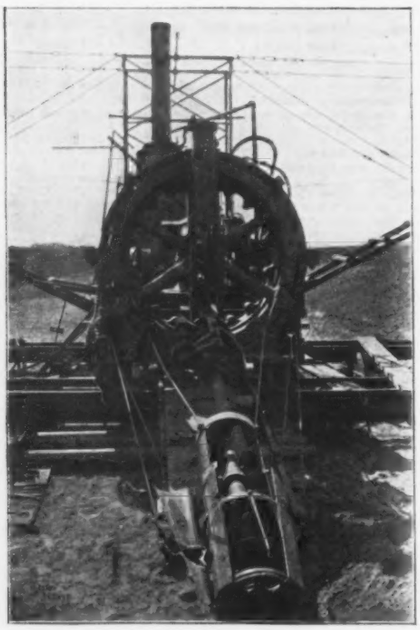

Fig. 1.—View Showing Operating and Excavating Mechanism of Auger Excavator and Conveyor Used on Illinois & Mississippi Canal.

machines is the one shown in the illustrations, Figs. 1 and 2. This machine, popularly known as the "Big Auger," has not been successfully operated, although its designer and builder had high hopes of its making a record as a dirt mover. The principle of its operation differs from that of the ordinary excavating machine, in that it involves the continuous movement of a small volume of material instead of the movement of large intermittent loads, as is the case with steam shovels and other machines of a similar character.

The "business end" of the machine consists of a series of projecting blades or cutters, which revolve around a cylindrical conduit of sheet iron. Within this conduit revolves a screw conveyor which carries the material to the upper end of the conduit, where it falls on a belt conveyor, running back under the center of the machine. Fig. 1 shows one of the blades or cutters in place, the cylindrical conduit with screw conveyor and the central belt conveyor.

The shaft on which the cutters revolve is mounted on a ball joint, and works inside the hollow shaft carrying the screw conveyor. The engine for driving this mechanism is a small affair, and is mounted on the upper end of the shafting. Power is transmitted by a worm gear to the main or inner shaft. The revolution of the outer shaft is effected by means of the elaborate system of gear wheels seen in front of the large vertical circle. This circle is in two parts. The outer part is rigid and the inner revolves through 360°, carrying the shafting to any desired angle. The air cylinder in front of the circle has a piston attached to the shafting, and is intended to take up any shock or jar that may be caused by the cutters striking boulders or other solid matter.

The two wings projecting from the sides of the machine (Fig. 2) carry the belt conveyors for taking the excavated material to the spoil banks on either side. The machine is mounted on a carriage which travels from side to side of the cut, as the excavation progresses. The lateral conveyors come into action alternately as the machine passes from one side of the center to the other. The plan of operation is as follows: The material, after being deposited on the central belt conveyor, in front of the machine, is carried to the rear, where it is taken up by one of the lateral conveyors and dumped on the spoil bank.

The machinery is operated by three engines; one for turning the front shaft, another for working the belt conveyors, and the third for turning the vertical circle. As already stated, this machine is still in the experimental stage, and no attempt has been made to place it on the market. Its chief claim for novelty consists in the boring or excavating arrangement. It is evident that considerable improvement will be necessary before it can be considered a commercial success.

FIG. 2.—GENERAL VIEW OF AUGER EXCAVATOR AND CONVEYOR USED ON ILLINOIS & MISSISSIPPI CANAL.

*Tampico, Ill.

GARBAGE COLLECTION AND DISPOSAL AT MOLINE, ILL.*

By Edward Kittilsen.†

For many years in the early history of the city, and up to 1882, all garbage and refuse matter was taken to the river front at the most convenient point, or taken to the outskirts of the city, and dumped on any vacant ground. People got rid of kitchen refuse as best they could. In 1883, signs were put up prohibiting dumping along the river front, and regular dumping places were established by the city authorities. Under the Board of Health, in 1882, the sanitary work in reference to the care and disposal of garbage was started. It was ordered that kitchen garbage be deposited in tight receptacles with a cover, and the property owners were directed to remove the same at their own expense. This order was never complied with.

In 1883, the Mayor ordered the City Marshal to have the garbage and filth removed from the alleys at the expense of the city. Water-tight boxes or tanks, with tight covers, were made and were placed on common farm wagons. In this way the garbage was gathered and hauled three miles into the country and buried. This system was carried on for several years. Garbage collected in districts having no sewers contained 50 to 66% of water, and this was expensive to bury, especially in soil composed of yellow clay. In 1894, for the purpose of getting rid of the water, I tried an experiment which proved a success. I constructed a tank similar to that used by masons in slacking lime, but on a larger [illegible] and in one end were put two sets of ½-in. screens [illegible] was connected with the sewer, and a 2½-in. hose [illegible] 1½-in. nozzle was connected to a fire hydrant [illegible] wagons dump the garbage into this tank, where [illegible] thoroughly washed, each load requiring 10 to 15 m[illegible] The putrid matter is washed out and the garbage b[illegible] almost odorless. The garbage is then sprinkled [illegible] lime or other disinfectants. After the water has [illegible] off the garbage is reduced in bulk and weight, [illegible] what remains of 8 to 15 loads can be removed [illegible] team, and two teams now do the work formerly re[illegible] five teams, besides which there is no water to bu[illegible]

Mr. Kittilsen stated that there is no accumulat[illegible] of grease in the sewer, the liquid waste containing [illegible] enough to cut the grease and prevent it from col[illegible] —Ed.

In the spring of 1895, the old garbage boxes (for collecting garbage) were worn out, and it was impossible to keep them odorless by scrubbing with disinfectants after each load. They have been replaced by four odorless steel dump carts, manufactured by the United States Sanitary Co., of Washington, D. C., which can be kept clean at very small expense. The carts hold 54 to 64 cu. yds. of garbage, each, and are very excellent vehicles for the purpose. Dry refuse, ashes and rubbish are gathered in common dump carts and removed to the city dump, which is covered daily with earth. Garbage is only taken from private residences by the city. All business houses, hotels and restaurants remove their own garbage.

The city contracted for and had two crematories built, one for garbage and the other for night-soil, but did not accept them, on account of their not being able to fulfill the contract requirements. Destroying garbage by cremation or utilization in any furnace that has yet been constructed, is not an economical plan, the expense of operating being too great, especially for small cities. There is a fortune to be made by the person who invents a furnace which can burn garbage at such small expense as to be within the reach of all cities. This is undoubtedly one of the most sanitary ways of disposing of garbage. Burying garbage is the cheapest sanitary way of disposing of it, when cities have ground available. The cheapest method known is to dump it into the river, but this is a barbarous method, as it pollutes the water for the cities further down, which depend upon the river for drinking water, and legislation should be enacted to stop such a practice. The city of Moline does not allow anything to be dumped into the river.

It has cost $6,013 to collect the kitchen refuse and all rubbish and waste material from the residence portion of the city, an area of 21,800 acres, with a population of 21,000. In this work we have used the four steel dump carts for removing dry rubbish and street sweepings, with 9 horses and 12 to 14 men. The above cost includes covering the city dumps with earth, and sweeping 2¾ miles of brick pavement. We have collected the garbage over the entire city two or three times a week during the summer months, and once or twice during the winter. Garbage can be removed at less expense in the winter, as it can be deposited in old boxes and barrels and will freeze. When the receptacle is full it is thrown upon the cart and taken away, the property holder putting a new receptacle in its place. The city of Moline owns the horses, carts, tools, etc., used by the Health Department for cleaning the city. I believe this is the only city in Illinois owning a complete equipment for this purpose.

It is my opinion that with the use of the sanitary garbage carts, the galvanized iron receptacles at the houses, and the dump carts for dry rubbish, our system of washing the garbage in tanks and removing the solid residue to be buried outside the city, is the cheapest and most sanitary method of disposing of our garbage. As to whether the collection and removal should be done at the expense of the city, or by the people at their own expense, I say the former is the best way. As soon as the people are obliged to remove it at their expense they will not remove any if they can help it. They hide it, put it in, vaults or sheds, under buildings, anywhere out of sight. If the city does the work, the people will bring all filth and rubbish to light, and will clean up their property and keep it in a sanitary condition.

*Abstract of a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors, at Moline, Ill., Jan. 24.

†City Marshal, Moline, Ill.

THE CASE OF THE RAMAPO WATER CO. vs. Wm. R. Hearst, proprietor of "The New York Journal," was decided by Justice Chester, of the N. Y. Supreme Court, on Jan. 18, in favor of Mr. Hearst. Justice Chester finds that the latter states facts sufficient to constitute a cause for action, and that he has a legal capacity to sue; the company is to answer within ten days. Mr. Hearst brought action to dissolve the company's charter, because it failed to enforce its corporate rights by engaging in its lawful business. He alleged that the company was secretly buying up water-rights, especially in New York county. The company demurred to the complaint, and it is this demurrer which was dismissed in the decision above noted.

*This washer was visited by the Society during the convention. It consists of a sloping platform or shallow tank, at the lower end of which are two parallel ½-in. screens with vertical wires, the screens being about 12 ins. apart.

THE GRAPHIC BLOCK SYSTEM OF RECORDING CAR MOVEMENTS.

One of the most onerous tasks of a railway Car Accountant's office is that of keeping a record of the movements and the location from day to day of the freight cars owned by the company. The old and still common method of performing this work is to record the movements in special record sticks. This system is generally recognized as having many disadvantages, and various attempts have been made from time to time to improve upon it. One of the most successful of these attempts is the graphic car record system developed by Mr. G. H. McNamara, Car Accountant, Norfolk & Western R. R., Roanoke, Va., and now in use on

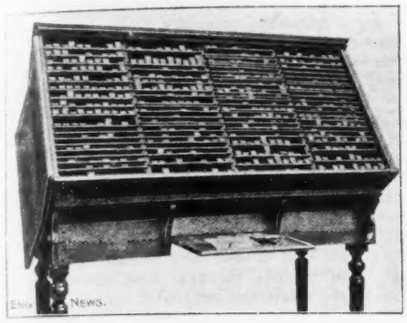

Fig. 1.—View of Filing Case for Graphic Record System of Recording Railway Car Movements. G. H. McNamara, Car Accountant, Norfolk & Western R. R., Inventor.

quite a number of prominent railways. Briefly described, this system consists in using a separate card for each car, these cards being carried in special holders or "blocks" of wood, which are arranged in special filing cases.

A graphic record case constructed to keep the record of 4,000 cards is 7 ft. long, 3 ft. 4 ins. high and 8 ins. deep, and rests on a supporting rack at an angle of about 45°, and at a convenient height to work at standing. Fig. 1 shows the general appearance of such a case, but of one of the smaller sizes. A 4,000-card case is divided by six vertical partitions instead of three, as in the case illustrated, making seven compartments to the case. Each compartment is again divided by nine rows of three ⅛-in. wire rods, extending from the top to the bottom of the case. The first rod in each row is placed 2 ins. from the front, the second 4 ins., and the third 6 ins. These rows of rods, it will be observed, divide each compartment into ten spaces, and each compartment is also divided by horizontal shelves, which have suitable saw cuts in them into which the wire rods slip when the shelves are shoved into place. These shelves rest on ratchets at the back of the case and on escutcheon pins in the dividing partitions, and can be moved together or away from each other to give the space required. The blocks carrying the record cards rest on the shelves and slip endwise between the rows of wires.

The record blocks are 8 ins. long—the depth of the case—1 in. wide, and ¼-in. thick at the ends. Fig. 2 is a sketch of one of these blocks with the card containing the record in place. As will be seen the front end of the block carries the car number and has a pin inserted at the right-hand side of the number, which acts as a handle. The rear end of the block is cut to a point so that they may be inserted between the wire rods more readily, and also to prevent interference with the ratchets at the back of the case. The top of the block is cut out to a depth of ⅛-in., to a point within 1 in. from each end, and the thicker parts at the ends have the saw cuts extending 3-16-in. further inward to hold the cards. Three cards take up the space of these saw cuts. All these various features are clearly shown by Fig. 2.

As already stated, the blocks slip endwise into the record case, each block slipping into one of the ten spaces into which each compartment of the case is divided, as previously described. Blocks representing cars whose numbers end with zero or naught are put into the first space at the left and all whose numbers end with nine are put into the last space on the right. Between these extremes are placed in sequence the numbers ending with the integers one to eight, inclusive. For each foreign road there are two shelves, except for roads handling only a very few cars, which are grouped, the upper shelf holding cars delayed 15 days and over, and the lower one holding cars delayed a less period, the 15-day cars being transferred daily from the lower to the upper shelves. The color used for the car number on the ends of the blocks indicates the class of equipment to which the car belongs, whether flat car, gondola car, box car or other kind.

On the topmost of the three cards held in the block are placed the records of the movements of that car whose number the block bears. This record is made from the regular reports, and consist of the station number at the left and the date at the right, as shown by Fig. 2. For example, in the illustration the last entry B. & Me. 9-6 indicates that car No. 12,491 was delivered to the Boston & Maine R. R. on Sept. 6. When the entry is made in black pencil it shows that the car was loaded. If the entry is in purple pencil it indicates that the car is empty. The movements on foreign roads are denoted in ink. Obviously the symbols may be extended much further than is here indicated, and each road may divide and subdivide the arrangement of its record case, record cards and entries, according to its individual requirements. The cards are filled with entries on both sides, and when all three are filled up the older one is filed in a suitable drawer attached to the record case, and a clean card is put in its place in the block.

The preceding description indicates quite clearly the nature and operation of the graphic car record system. It is, as previously stated, in use on a number of railways, among which the Norfolk & Western, the Lake Shore & Michigan Southern, the Boston & Albany and the Canadian Pacific are representative examples. As indicating the experience of the road last named with the system, we quote as follows from a report submitted to the Eastern Association of Officers in Charge of Car Service, held at Boston, Mass., Feb. 4, 1897, respecting it by Mr. J. P. Driscoll, Car Accountant:

When the graphic car record was introduced in this office on Jan. 1, 1896, it was our intention to keep, if possible, a record of all cars, both foreign and local, passenger and freight, but this was found impracticable, principally on account of the time employed in making sticks for every foreign car received on the line.

Each of our nine record cases is divided into sections, each section corresponding with that part of the line under the control of an Assistant Superintendent, and our

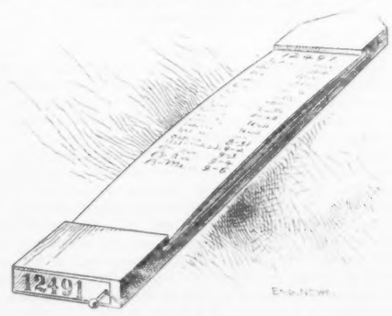

Fig. 2.—Perspective View of Record Block Containing Record Cards, Graphic Car Record System.

principal connecting railways. The railways on which we have never more than five or six cars are put in the "Miscellaneous" section, so that the record sticks representing the 2,000 cars are in one case and move in that case according as the cars move on the line or on foreign roads. Our conductors' reports are sorted into sections corresponding with the sections in the case before being issued to the clerks to record the movements of the cars. In this way it will be seen that when a clerk gets a report on which the conductor has entered the wrong number of the car he cannot enter the movements, as the chances are that the stick representing the car is elsewhere in the case. It is also to the interest of the clerk to enter only correct movements, as should he enter an incorrect one he will also necessarily place the stick in the wrong section of the case, so that when he wants to enter the correct movement of the car it might take some time to find the stick.

To do the work in the graphic car record it requires more experienced record clerks than it did to keep the record in the old way, and consequently they control more salary, but this does not increase the cost of the records, for the reason that there is no duplication of work by the new system, the record of the cars on the line and on foreign roads being kept by the same clerk, who also makes out tracers for cars delayed on the line and foreign roads which was heretofore done by clerks other than the record clerks.

I have also found that a great amount of time is saved when tracing for cars delayed at stations on the line; in fact, I will say that until the graphic car record system was inaugurated, satisfactory or correct tracers were seldom issued for cars delayed on this line. At different seasons of the year we have a surplus of flat cars on Western and Pacific divisions, while on the other divisions we have a shortage, and consequently only trace for cars delayed on the part of the line where cars are required, which is easily done from the cases. A clerk can trace from the case for cars delayed on any one or two divisions of the line in less than half an hour. By the old system he would have to go all through his record to trace for cars delayed on any one division, which might take perhaps two days, because it would be necessary for him to examine the record of every car.

After a number of changes in the system which were considered advisable from experience, I have found that a good record clerk can keep the record of the movements of 2,000 of our standard box cars, and keep them in such a manner that there will be no comparison between the new system and the old system of car records.

As you know, with the old system a careless record clerk could enter a large number of incorrect records in his book, which could not be detected unless a special examination was made of his book. He could also, if dishonest, check off a large number of cars on conductors' reports and never enter them in his record, which might also not be detected. This has occurred in this office on two or three occasions but was detected at once. There is no danger of this with the new system of graphic car records; in fact, it it not possible for a clerk to do his work and omit or enter incorrectly movements on the record sticks.

Taking everything into consideration, I prefer the graphic car record to the old system of record books. It of course takes a little, very little longer to enter the movements of the cars, but there is no duplication of work and it takes less time to trace for cars delayed on the line and on foreign roads, and also gives you at a glance the location of all your equipment; it is therefore my advice to all car accountants to introduce in their offices as soon as possible the new graphic car record.

The graphic car record has certainly some small defects, but not so many as would be imagined at first glance, and these defects can be materially reduced by having the conductors and agents forward their reports promptly. One of the good points of the graphic car record is that we can trace for cars delayed on foreign roads, and what is better still, for cars delayed on our own road in much less time than we could from the book system. As an illustration, I would mention that about four weeks ago our General Superintendents made an estimate of the number of flat cars that would be required on each division for the timber business and ballasting purposes in the course of a couple of months, and our Superintendent of Car Service at that time asked me for the location of our 5,000 flat cars to enable him to work the cars where required. I gave him the location of our 5,000 flat cars in seven minutes. In the old way it would have taken two and a half or thre days to have given him this information, and then you must remember the location would have been three days old.

A similarly favorable experience is reported by Mr. L. A. Anthony, Car Accountant, Boston & Albany R. R. On this line two record clerks keep track of the movements of 6,000 cars. Mr. McNamara, the inventor of the system, reports the following method of operation as the practice of the Lake Shore & Michigan Southern Ry., under his direction as chief clerk in the Car Accountant's office:

In the offices of the Lake Shore & Michigan Southern Ry. each clerk is allotted certain cars, the records of which are kept by him, both at home and abroad, the number of cars assigned to each clerk being 4,000. Each clerk in addition to keeping the records of the cars allotted to him checks up repair bills, furnishes the movements of misused cars, keeps a daily record of the number of cars at home and on foreign roads, and all other work generally done by a record clerk, except furnishing statements of cars on foreign lines to be traced for. This work is done by the tracing clerk, who does not interfere with the record clerks, as two clerks can work at the same time, which is a great advantage at times when for any cause a clerk is absent or is having more than his proper proportion of the work. The movements of the cars are all entered from the original reports, no separation being made by the conductors of the local from the foreign, and the average number of entries is about 1,500 per day for each clerk. It has been found that the liability to error in entering movements is less than is the case with books.

THE REMOVAL OF DUST FROM BOILER ROOMS.*

By Albert A. Cary, M. Am. Soc. M. E.†

In the Atlantic States oil burning under boilers has become too expensive a luxury to be much indulged in, and, although one can find an occasional oil-burning plant today, the old installations are fast disappearing, and coal is being substituted for oil, followed by a material saving in the cost of fuel.

During the past year a manufacturing concern in New Jersey consulted me about making a change of this kind, and the problem was somewhat complicated with a demand that the new plant should be as non-productive of dust as the oil-burning plant had been. They informed me that the principal reason why oil had been adopted originally was because of its freedom from dust. This concern manufactures a rubber-covered insulated wire, and those acquainted with the manipulation of rubber will recall that it is kept in a gummy or sticky plastic state during its entire process of manipulation, and, therefore, any dust will stick to it tenaciously, and such foreign matter will affect its power of insulation appreciably; therefore in this factory every source of dust is done way with as much as possible.

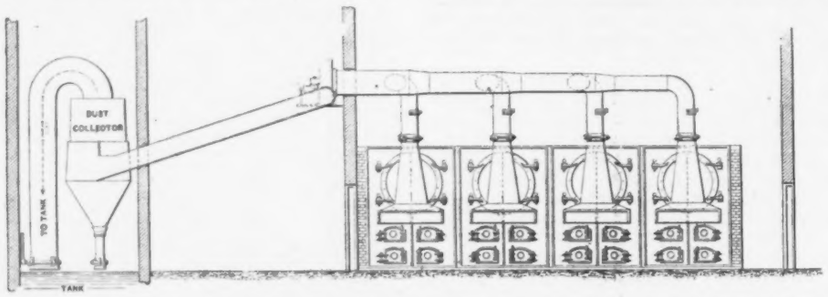

FIG. 1.—ELEVATION OF FRONT OF BOILERS, SHOWING DUST COLLECTING APPARATUS.
A. A. Cary, M. Am. Soc. M. E., Designer.

The factory is long and comparatively narrow, with a wing running back from each end, thus forming a sort of square U, and having a square courtyard in the center (with buildings on three sides of the square). In about the center of this court the boiler house is placed, thus giving any ash or dust coming from it an excellent opportunity to enter the many windows of the factory which surrounds it.

When oil is used, perfect cleanliness (so far as dust is concerned) is possible, but when coal is substituted, dust will arise from every shovelful of coal that is fired, and afterwards the dust from the ash and refuse, when fires are cleaned, will scatter itself everywhere. The avoidance of such trouble was a problem to be solved.

A number of schemes presented themselves to my mind. The placing of screens in the factory windows interfered materially with the free ventilation of the various rooms, this being very essential in a rubber factory. Another scheme included a dust house adjoining the boiler room, into which the dust-laden air might be blown and filtered to the outside air, through wire and cloth screens; but I condemned this on account of its merely transferring the trouble from one place to another close by, and, perhaps, aggravating the trouble when the screens were taken out and cleaned periodically. However, I finally devised a method which seemed to meet all objections. The steam plant has its boiler room and engine room adjoining. The boiler room contains four horizontal tubular boilers, 66 ins. in diameter, and 18 ft. long, with 80 3-in. tubes, having a nominal rating of 100-HP. each. The smoke flues are connected to the rear of these boilers. I have provided a dust house next to the engine room, but on the opposite side from the boiler room. This dust house is designed so as to receive another 100-HP. boiler, which will doubtless be required as the demand for steam increases. Surrounding conditions made it impossible to erect this house at the opposite end of the boiler room, where it would otherwise have been placed.

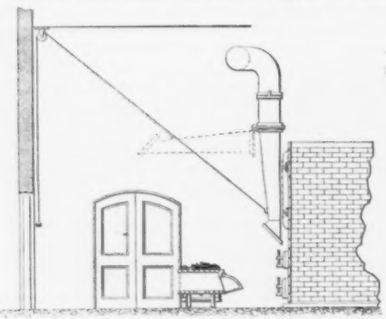

Fig. 2.—Cross-Section Showing Hinged Inlet Pipe of Dust-Collector.

Figs. 1 and 2 show the general arrangement of ducts, exhaust fan, etc. It will be seen that the four suction ends of the ducts terminate in comparatively narrow open mouths, extending almost across the entire width of the boiler front, and they are placed directly above the firing doors. All coal is brought into the boiler room on an industrial railway in Hunt's charging cars, made for this purpose, each car carrying one ton. These cars are filled from a distant coal pocket, and are then pushed by one man in front of any boiler which may need coal. The side of the car is then dropped like a hinged shelf, and coal is shoveled direct from the car into the furnace. As the car is easily moved from one boiler to another, no loose coal is dumped on the boiler room floor. It will now be seen that any dust rising from the shoveled coal will be drawn into the suction mouth of the exhaust dust, since the shoveling operations take place only in front of these mouths.

When the boiler furnace is being cleaned, any dust accompanying the ash and clinker, as they are pulled out of the firing door, is drawn directly into the suction mouths, and this is again the case when this refuse is shoveled from the floor into an empty charging car, to be taken out of the boiler room.

Before following this dust out of the boiler room I would call attention to the construction of the vertical suction pipes above the firing doors. These pipes, it will be seen, are directly in front of the upper cleaning doors of the boilers. In order to open these doors, when the tubes require cleaning, a hinged joint is provided in the suction pipe, as shown in Fig. 2, and the lower end of the duct is thereby raised out of the way.

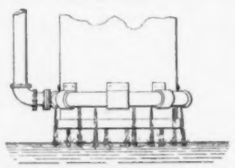

Fig. 3.—Spray Pipe at Outlet of Dust-Collector.

After the dust enters the ducts it is discharged by the Sturtevant steel-plate exhauster (placed in the engine room) into a centrifugal dust collector placed in the dust house. The heavier particles are discharged through the bottom pipe of this collector, and, as a further precaution, to catch any light floating particles which may escape through the upper or air delivery end of the collector, a pipe is run from this top opening, and, bending downwards, terminates within 2 ins. of the surface of water held in a tank placed below the level of the floor in the dust house. The bottom-discharge pipe from the dust collector also terminates similarly, and thus all the dust, etc., is projected upon the surface of the water, where, as it gradually becomes soaked, it sinks to the bottom of the tank, from which it can be either washed out with a hose and stream of water, or else be shoveled out as mud.

In order to catch any particles of dust which might otherwise escape, a 1-in. water pipe is bent to a circle and secured concentrically around the lower ends of each of these delivery pipes, as shown in Fig. 3. The lower sides of these pipe rings are perforated with ⅛-in. holes, so as to produce a constant shower of water around the outlets.

This arrangement leaves a free escape of air, essential for best results with the type of fan used.

A sewer connection near the top of the tank keeps the water at a constant level, and the added water from the sprays thus has a tendency to float off a considerable amount of the lighter floating particles before they have time to sink.

* A paper read at the New York meeting of the American Society of Heating and Ventilating Engineers.

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THE RELATIVE VALUES OF OZONE AND SLOW SAND FILTRATION AS A MEANS OF PURIFYING WATER.*

At the 39th annual meeting of the German Society of Gas and Water-Works Engineers, recently held in Cassel, a paper was presented by Dr. Th. Weyl, of Charlottenburg, upon the use of ozone for the sterilization of drinking water, which brought forth a most notable discussion. The author described an experimental installation for the treatment of water by this process, which resembled in a general way that used by Mr. Sopert and described in Engineering News for Oct. 19, 1899. The author said, that for the sterilization of 1 cu. m. of water there was required, according to the amount of organic matter present, from one to three grams of ozone. The cost of the sterilization of 1 cu. m. of water would amount to between 2 and 4 pfennigs, according to the quantity of ozone required, the rate of interest on capital, etc. This is equal to from $18 to $36 per 1,000,000 gallons. The author then raised the question whether the process of sterilization of water by ozone might not be expected to supersede the use of sand filters in the treatment of water supplies. He declared that there were important objections to the use of sand filters; that a number of researches had shown that filters cannot be considered to be entirely germ proof, and that it had also been shown that many epidemics of typhoid fever had been caused by drinking water which had been filtered through sand filters. Even though the filters are improved, said he, as they have been since the noteworthy researches of Frankel and Piefke, the sand filter remains, especially with very bad raw waters, an apparatus of uncertain operation. On this account, he said, hygienists will be greatly pleased to find a method for the sterilization of water which will entirely dispense with the use of sand filters. The author then suggested that under some circumstances sterilization by ozone might become much cheaper than filtration.

The discussion was opened by Engineer Lindley, of Frankfort-on-Main, who said:

> The paper that we have heard is certainly of great interest. But I believe that those who are in a position where they must supply great cities with water year in and year out, and who have, during long series of years, observed the operation of large sand filters, and have studied carefully the results of such operation, will not allow to go uncontradicted a statement like that expressed by the author at the end of his paper, namely, that sand filters are among the most dangerous appliances to be found in the control of cities. Such an expression reflects upon the sand filters which supply our great cities of Berlin, Hamburg, Breslau and others with good and pure water; and on those which for many decades have supplied the larger cities of England, also, with good and pure water; cities in which it is known that the mortality statistics are not more unfavorable than in those supplied with well water or spring water; cities, further, in which to the best of my knowledge it has not been possible in any way to show that the sand filters have worked danger.
>
> In my opinion the simple counting of bacteria in certain cases is absolutely insufficient foundation for such a statement, and the matter must not be allowed to remain without contradiction; and I believe that I represent the sentiments of many who have profited by the action of this so-called dangerous apparatus for many years, when I raise my protests against this statement.
>
> Let us consider for a moment what beneficent results these sand filters have given in many years in the supply of great cities; and let us consider also the numerous attempts which have been made to replace these sand filters by other methods. One of these is mentioned in the paper as the Anderson process, the so-called "revolver," a drum in which by means of iron a purifying action on the water should result. This process was in its time received with great applause. Many expected good results and made experiments with it; and I hope to hear from my honored colleague, Herr Halbertsma, of Holland, who probably is in a position to give you later information regarding it. What I also have heard from other sources is that in many places where this apparatus was used the drums are no longer kept in service.†

* Abstracted from the German, as given in Schilling's "Journal fuer Gasbeleuchtung und Wasserversorgung," for Nov. 25 and Dec. 2, 1899, by Allen Hazen, Assoc. M. Am. Soc. C. E., 220 Broadway, New York city. A brief abstract of Dr. Weyl's paper, which precipitated the discussion here given, was published in our issue of Nov. 23, 1899. Since the main part of this article was put in type the "Technologie Sanitaire" for Jan. 1 has reached this country, and Mr. Hazen has abstracted from it a few paragraphs on this subject, which are appended.

† That is, the treatment of the water with iron in revolving cylinders has been abandoned, although the sand beds provided for subsequent filtration are still in use.—Ed.

Gentlemen, in scientific circles it will not do for one to set up the results of a little first experiment against a well-proved system, which on an enormous scale and through decades has been carried out with success. It is bad beginning to designate as dangerous that which is well established, and to set up uncertainties without being in a position to put something in its place which has also been used in more than a first small experiment, and which has also, under similar conditions, shown its usefulness and feasibility. By such a proceeding one does not advance, but on the contrary retards, the progress of public health.

Herr Lindley then mentioned the matter of cost, and called attention to the fact that while the results which had yielded sterile water were obtained with comparatively large quantities of ozone, the estimates of the cost of operation were based upon the use of much smaller quantities. He then continued:

Further, I may allow myself to raise the question whether, even in the event that this treatment with ozone should do all that has been claimed for it, it could replace sand filters. I imagine that it would rather be in the nature of a supplement to them. Dr. Weyl has shown that a very considerable part of the ozone is required by the organic matters, that is to oxidize them. Why, now, should we waste this valuable material on those substances which can be more cheaply removed in other ways, namely, upon the large amount of suspended organic matters? Why not remove these by sand filtration, and apply the ozone process to the effluent, when it would have a better chance to work upon the remaining bacteria and to kill them; and in this way accomplish the work which in the sand filter remains undone, to kill the remaining bacteria?

From this point of view naturally follows the question, if in such cases it would not be better to use the ozone process, not always, but only in those times when such aid is really necessary, when an unusual danger is at hand, when the fear of an epidemic raises the question as to the absolute efficiency of the sand filters and makes advisable the application of all means tending to certainty, and is such as to justify a considerable sacrifice to secure it? I ask these questions of the author, because from his presentation of the case it seems to me most doubtful whether the process of ozone treatment will be able to take the place of filtration in other respects than that of removing the bacteria, especially in the clarification of turbid water. It seems to me that by killing bacteria in this way neither the fine clay and sediment nor the suspended matters, even those of organic origin, will be removed from the water; and to remove these is one of the most importnt functions of our sand filters, which should make the water clear, and suitable for use in the city.

In conclusion, I cannot forbear to say how important it seems to me that in this meeting further voices should be raised in the right direction. We may not forget that we work here in our society, not only among engineers and practical men, but also before the eyes of the public and the laiety, and also before the eyes of the hygienists, of whom, unfortunately, a large number consider questions of the nature of those under discussion only from the standpoint of the number of bacteria, and have not yet learned to use the discretion, which, to our great pleasure, we have found in many bacteriologists, in passing upon water, and our appliances for purifying it. It would be very much to be regretted if by failure to say clearly what we think, it should be thought by some that we, by our silence, had given assent to what has been said.

Dr. Weyl then said: Gentlemen, it is quite clear that my paper could not be allowed to pass without challenge, and certainly most clear that Herr Lindley, who has been of the greatest service in sand filtration, feels that it was aimed at him. I have said that the sand filters are, from hygienic considerations, the most dangerous appliances operated by cities. Gentlemen, I would like, now that this question has been brought up, to cite a few facts. Of course, it is impossible for me to give you an adequate picture of the whole situation. I can only mention some of the cases which occur to me at the moment. I will first recall to the gentleman the role that cholera has played in London. There the sand filters take their water from the Thames. If I am not mistaken, it was in 1849 that the cholera was so prevalent in London; and it was the district in the city of London which was supplied from a certain water-works which had cholera, while, on the other hand, those districts which were supplied from the other companies had no cholera.

It should be noted that in those days there were no bacteriologists, nor plate cultures, nor the base hygienist who later invented them. This fact cannot be denied, and the result of it was that the water company was obliged to move its filtration works upstream. And now happened what was nearly an experiment planned by nature to support the hygienic doctrine. Five years later, in 1854, when the cholera was again prevalent in London, came the astounding report that in this same district no cholera occurred.

I need not, however, go so far back, but only refer to an epidemic of typhoid fever in Berlin that in its time was much spoken of. This typhoid epidemic in Berlin, in the year 1889, had its origin, as known, in the water-works at the Stralau Gate. The observations made at that time showed with certainty that in those parts of the city which were supplied with water from the Stralau Gate the typhoid fever appeared. On the other hand, those parts of the city supplied from the water-works at Tegel remained free from typhoid. Do you believe that the city authorities would have given up these water-works if it had not been necessary? The water-works at the Stralau Gate had to be closed because the water at the intake of the water-works had become too much polluted to allow it to be properly purified by sand filtration.

I remind you, third, of the cholera epidemic in Nietleben, near Halle, in the year 1892. This case was accurately investigated by Robert Koch, and he found that the badly operating sand filters had allowed cholera bacteria to pass them.

I would further mention the conditions in Altona during the winter of 1892-3. At that time there was a typhoid fever epidemic which the health officer, Herr Wallichs, showed to be due to the influence of frost upon the sediment layer on the sand filters which became broken and allowed the infected water containing typhoid bacilli to pass it unfiltered.

The above-mentioned facts cannot be contradicted. Certainly they were due in part to causes which have been removed with the help of the bacteriological methods, to which Herr Lindley is not quite friendly. But, gentlemen, we do not rely upon these bacterial methods. The "bacteria counter," as Herr Lindley designates him, has other resources—that is, the geographical-statistical method, which hygienists had used before the days of Pasteur and Koch. When on a certain area a number of cases of disease are found, and when at the same time on neighboring areas the disease is not found, then we must examine for the cause of this phenomenon. As we know that drinking water is a carrier of cholera and typhoid fever, so we must come to the conclusion that the water is better in one area than in the other. When we finally take note that in houses where sickness occurs a particular water is used exclusively, one that comes from a certain sand filtration works, the evidence is completed that the sand filters have allowed the passage of the germs of that particular disease. It was upon these grounds that I based my statement that it would be fortunate if we could do away with sand filtration.

Regarding the "revolver" process, which Herr Lindley has mentioned, I might say that the same is now in use in the neighborhood of Paris. I have seen it at Choisy le Roi. There the water from the River Marne, which we certainly should regard as hardly capable of purification, is subject to the revolver process. The effect, however, is insufficient.

Now, gentlemen, I come to the criticisms which have been made upon the execution of my experiments; and there I believe I have failed to make myself clearly understood. (The author then explained some details concerning the method of making ozone, and the quantities required, and then continued:)

With this I will close my answer. The sand filters have proved their usefulness. I wonder that they do as well as they do. But that is no reason for opposing technical progress. I have certainly not said that we should think of giving up the use of sand filters. That would be foolish, gentlemen. It has only been my purpose to suggest that perhaps in future the ozone method would be of great service, and that its effect, as measured by bacterial methods (and we have as yet no others for water), was found to be approximately equivalent to the effect of the sand filters.

Gentlemen, in your circles opposition to what I have said will not cease; but I allow myself this opportunity to recall the history of a question that for hygienists and city authorities has been of similar importance, namely, the controversy over separate and combined sewers. It was an engineer of great reputation who stood near to your own circle, who was most active in opposing the introduction of separate sewers; but you know what came from that discussion. Separate sewers were quietly built, and with great advantage; and I, myself, believe that it will be much the same with ozone. We shall take pains to oppose and set right the misstatements about the method, and we will then hope that gradually it will happen that as the ozone process is perfected the war with the sand filters, as I will characterize it, if I may, will be ready to proceed.

Herr Director Beer, of Berlin, said: Gentlemen, we live in a time when science is making extraordinary progress, and this progress is recognized in every point but one, and that is in filtration; and from this standpoint I would answer something of what Dr. Weyl has said. He represented that filtration is not in all respects satisfactory because, as he has told us, the cholera epidemic in London in 1857 compelled the water company to move their intake to a point where the raw water was better. He then told us that the Stralau water-works were closed because at one time typhoid occurred in those parts of the city which were supplied from the Stralau works. Now, gentlemen, you see in one case in England very dirty raw water was used and a change was made to a better raw water. I think that we came to the standpoint long ago that we should, wherever possible, select as good a raw water as may be, and I think that it is certainly recognized that we should, if possible, avoid such an extremely polluted water as the Thames was even at that time. The evidence that the water from the Stralau works has made typhoid epidemic in Berlin is, unfortunately, up to the present time, not yet produced. Only a part of that portion of the city supplied from the Stralau works suffered from the typhoid. At that time about one-third of the whole city of Berlin obtained water from Stralau. Of this part of Berlin, it was only a very small part in which the typhoid appeared. If it was really true that the Stralau works were responsible for this, in my humble opinion, all that part of Berlin supplied from the Stralau works would have had typhoid fever. It is true that the Stralau works were closed; but it must not be concluded that they were closed for the same reasons that earlier led to the change in London which has been mentioned. The Stralau works were built in 1856. At that time Berlin was a small city. There was little navigation of the river, and the works were practically above and protected from the impurities sent to the river by the city. Afterwards the city extended. The eastern suburbs grew more and more. A whole manufacturing city appeared above the water-works, and naturally the raw water became worse and worse. The filter works, dating from 1856, and extended in the year 1874, were far from representing the requirements that one expects in a filter plant to-day. There was no pure water reservoir. There were no appliances to regulate the water quantities, and to measure the effluents from the filters. Then, after the epidemics in Hamburg, came great attention to the work of filters. Berlin was in the fortunate position to be able to give up Stralau and to build a great new water-works. This work would, in any event, have been taken up soon, perhaps in six months or a year. The inadequacy of the Stralau works and the absence of appliances for filter regulation were well known to us, and we were not reluctant to commence the new work a little earlier than had been expected. Instead of building over and improving the Stralau works, the new works were pushed to completion; but in spite of all this, and notwithstanding the very bad character of the raw water and the old materials in nearly all cases, the Stralau filters operated well and delivered good water which was not infected; so you see that the filtration was not so bad as has been believed, or bad enough to condemn the process.

I would also mention here what may be of interest. Two years ago, typhoid broke out in Berlin in four or five houses at precisely the same time. All of these houses received water from the Tegel works. These houses were in three separate streets, and were thus locally separated. At the time none of the hygienists, except Dr. Renvers, of the great hospital in Moabit, in which these typhoid cases were treated, suggested the possibility that these cases might have been caused by the water. The water at that time was subjected to a most searching examination. Then I must mention the cases of Nietleben and Altona, where in winter filters have operated very badly. Here, gentlemen, we find again the old truth which we must learn and have learned, that one must not clean and restore to service an open filter when it is deeply frozen. We also know that with very small and badly managed works, as at Nietleben, bad water can be obtained; and when one draws a conclusion from this, it would seem to me, as it would be if I were a foreigner and came to Germany, and the first man that I met on the street was drunk, and I thereupon came to the conclusion that all Germans were drunkards. Gentlemen, I hope to show you this afternoon, and also to give you substantial evidence of it, that our new filter works are so operating that every hygienist must be entirely satisfied with them.

I believe that one should take the good wherever it is found; so when to-day Dr. Weyl in a friendly way has explained to us a new process that naturally as yet is in the kindergarten, and as yet hardly graduated from the laboratory, and that for the present seems very expensive, I will not lay too much stress upon it; and Dr. Weyl will not be disappointed if we do not to-day at once go and build great works upon the process which he has described.

Herr Civil Engineer Halbertsma, of The Hague, Holland, said:

I will come at once to the question which Herr Lindley has directed to me, more recent particulars of the application of the revolver process, as Dr. Weyl has named it; but elsewhere it is known as the Anderson process. It is in reality no revolver. The bacteria are not shot dead by it, although they may be in some measure pinched and killed by the falling iron. The Anderson process in Holland is only used in those places where one has not the means or opportunity to secure a sufficient extension of the filters, as in Dordrecht, where the filtration works were very unsatisfactory. They were far from meeting the requirements of what is necessary for a filtration plant. The filters were also not tight, and the superintendent had to do the best that he could. If he asked the city authorities for money to build filters after they had spent a half a million on a whole new water-works system, the request would have been refused. The director, therefore, made himself familiar with the operation of the

Anderson process in Antwerp, and was satisfied that good results were obtained, and he hoped by the application of a similar apparatus to get along without extending the filter area. Apparently good results were obtained at first, but his successor in office has never been able to reach the same results, and in 1897 examinations by Dr. van't Hoff, of Rotterdam, showed that this apparatus was having no effect whatever upon the water. The purifiers are now used from time to time, but I think it is the intention to put them entirely out of use. In Gouda the example of Dordrecht was followed. The works belonged to a small stock company, and in the first years it was doubtless very difficult for it to meet its interest payments, and at this time it tried to help itself out by the installation of a purifier. Before that time the highly polluted and yellow colored water was treated with chloride of iron, and it was hoped by the use of the purifier to save this expense; but in this they were disappointed. When the income had grown so that the company could pay 5 and 6% dividends, and its means allowed the extension of the filters, the revolver purifier was donated to the city museum, and filters were again alone depended upon, but with the aid of chemical clarification, sulphate of alumina now being used.

Further, my distinguished colleague, Herr van Hasselt, Director of the Amsterdam water-works, made experiments upon the application of this process. He has a large filtration plant upon the River Vecht under his direction, and at that time the city prohibited the company from supplying water from the Vecht for drinking purposes. He made an investigation to determine whether the purifier would not make this water free from objection. Had he been able to accomplish this Herr van Hasselt would have rendered a great service to the city as well as to the English company which owned the works. The purifier, however, did not give the desired results. In Antwerp, also, the use of the Anderson purifiers has been discontinued.

In regard to the use of the ozone process in Holland, it is evidently quite impossible for one to be familiar with what goes on in water purification in all parts of the world, and so I take it in quite good part that Dr. Weyl is not quite accurately informed about the works in Holland. Also it is quite natural that when Dr. Weyl went to Paris and spoke with the representative of Herr von Tyndall, this gentleman has told him of the various experimental works and purification plants in Holland. It is certainly true that Herr von Tyndall has given himself much trouble and has spent very much money to make the sterilization of water by ozone technically applicable, but such works as those mentioned as in operation in Holland do not exist.

It is perhaps of interest for the assembly to know that Herr von Tyndall in reality has no ozone water-works in Holland in operation, not even for the smallest village. He has made only laboratory experiments, although on a considerable scale, with 1.5 kilowatts of current at Oudshoom, near Leiden, by means of which 3 cu. m. of badly polluted river water per hour were sterilized. The reason for this may be that we in Holland have no patents, and Herr von Tyndall chooses to make his experiments in foreign lands for this reason. We have in Holland, however, for this reason, with even more interest, followed the matter of experiments in other lands. Herr von Tyndall has always pointed us to his work at Paris; and it has further been suggested to us that very soon we must even travel to St. Petersburg. We wait then in Holland till we shall hear of the results at Paris (where Herr von Tyndall has a contract with the city) for a good report. There he is bound to furnish daily a not inconsiderable number of cubic meters of purified Seine water. It is now said that on the first of January the report will be ready, and the results will be made public, but as yet nothing of the sort has come to us. Many of my colleagues have asked, when can we learn the truth from Paris, but the answer remains forbidden; therefore, as to the results of Herr Baron von Tyndall's work in Paris we must make a large question mark.

Now, gentlemen, as the facts are, it seems to me that we as engineers and advisers of cities and water companies should be false to our trust if we advised them in the line of the honored author, to build no more filter plants, because they are dangerous, but instead to build ozone purification plants. We all know what a great difference there is between laboratory experiments and practical application. How many practical details must be solved! It is approximately as it was with the electric trolleys. In Europe the great endeavor was to use storage batteries, and it was said that the American overhead trolley system must not be used. Everything possible has been done, but finally we have had to come back to the practically-solved trolley system. I heartily hope that the gentlemen who are aiming to make the purification of water by ozone practicable will have early and great results, and that they will be able to help us to complete our work as filtration engineers; but I hope that the honored author will take it in good part when I say to him: All honor for your laboratory experiments, but when you institute comparisons between them and technical advances in sand filtration of decades, I would advise you to proceed with great care, and that you carry out your experiments on a sufficiently large scale until the process is practically complete and has demonstrated its adaptability through a considerable time. It will also be useful to you to take note of what is being done in this direction everywhere, and also in Holland. The work of my countryman, Herr von Tyndall, as well as of his former scientific collaborator, Herr van der Sleen, from Haarlem, is known to you. Less well is known to you that Herr Vosmaer, of Haarlem, has also been active in this question in recent years. I recently visited his laboratory, and he showed me his newest discoveries in the most friendly way; and I would also advise you, sir, when you again make a journey in foreign parts, not to neglect to visit the laboratory of Herr Vosmaer, in Haarlem. There is one other question regarding the ozone process which I must ask: How can we know, as Dr. Weyl has intimated to us, that with the application of ozone smaller filters can be used? We must always remember, as Herr Lindley has rightly said to us, that water must be freed from sediment and mechanical impurities. Good, but must we not also remove from the water the veritable churchyard of bacteria bodies which we form in the water, which we shall, as in future wars of people, kill in the water by one fell stroke? Is it allowable to let these bodies remain in water, and as such will they not cause putrefaction or the like? That is a question that is already beyond engineering, and falls more in the biological line.

It seems to me that we have no evidence that when we use ozone for the completion of our purification process that the filters can be made smaller, and if the filters cannot be made smaller, then the installation will certainly be no cheaper, but, on the contrary, somewhat more expensive. But that will not hinder me from recommending the ozone process as soon as it becomes quite clear to me that a corresponding improvement in the quality of the water will thereby be reached.

Herr Director Schertel, of Hamburg, spoke of a visit of one of his assistants to Dr. Weyl's laboratory in Charlottenburg, and said he thought that the results obtained were certainly no better than those obtained by filtration. He stated further that the cause of the disturbance of the Altona filters by frost (mentioned in the discussion) may fairly be considered a thing of the past, never again to occur in the work of filtration. We now have a very simple means of cleaning open filters in winter without removing the ice from them, and without drawing off the water. In Hamburg this method of cleaning filters under ice has distinguished itself, and it would give me great pleasure if any of the gentlemen who are interested in this matter would visit us and see the work in operation.

Herr Burgmann, of Altona, spoke as follows:

Gentlemen, the Altona water-works came into the possession of the city of Altona in the autumn of 1894. The cases to which Dr. Weyl refers happened up to the year 1893. All this occurred during the time when the works were in the hands of a private company. My highly honored predecessor, Herr Kummell, took strongly the position that the typhoid cases as they exhibited themselves could not be attributed to the water-works. It is nowhere proved that the germs of typhoid fever existed in the water which went away from the Altona filters.

The health officer, Dr. Wallichs, believed in this connection that the increase in typhoid cases in January, 1891, was connected with the extraordinary high bacterial numbers in the city water, and this indicated a connection between the typhoid fever and the water supply; while the possibility of this connection was almost entirely shattered by the fact that in the following year, February, 1892, at the time the typhoid fever appeared, the city water contained throughout a perfectly normal number of bacteria.

Now I must refer to the conditions in 1894, when, as I remarked, the works were taken by the city (the company naturally had not much ambition to build filters). We had to supply a consumption of water which already amounted to more than 22,000 cu. m. per 24 hours, from a relatively small filtering area, and you will all agree with me, that is, all you who have had to do with the operation of filters, that a filtering area of from 9 to 10,000 sq. meters was a very small allowance to filter 22,000 cu. m. and more per day (about 2,600,000 gallons per acre.—Ed.) of raw water of the character obtained at Altona. Gentlemen, I am entirely of the opinion which has been expressed by Herr Lindley in so concise and practical a way that the apparatus which Dr. Weyl has kindly explained to us should be thought of only as following filtration.

Herr Anklamm, of Friedrichshagen (Berlin water-works): Gentlemen, I would like to call your attention for a moment to a point which, so far as I remember, has not been mentioned by any of the gentlemen. I refer to the extraordinary difference in the cost of building and operation in the earlier times and at present. A filter years ago was very different from a filter as we understand it to-day. The different appliances of control that are of the greatest importance for the operation of filters, and which are to be found to-day in almost every new plant, were formerly never used; and it was on this account formerly impossible for the superintendent to drive a filter as it would be driven. It is hardly 25 years since we commenced to have some ideas upon rational filtration procedure, and to learn how we must filter. The appliances of control that are to-day regarded as of the greatest importance to the production of good filtration, and as quite indispensable, are as yet not 20 years old. It may be due to this great difference in the operation of filters that formerly bacteria of disease were not sufficiently held back by sand filters. To-day I believe it is true that a well built and carefully operated sand filter offers an extraordinarily complete protection against the spread of disease. I will only call your attention to the fact that the cases which Dr. Weyl has mentioned date from the older times with the exception of Nietleben. The filters at Nietleben, in my opinion, are not to be considered in this connection, as the construction was most faulty, and the operation entirely out of accord with our ideas. I need not express further the opinion which I have of such plants in operation, but I must most vigorously protest against the application of such results as showing that a well built and carefully operated filter should constitute a source of danger to a city.

Herr Director Schmetzer, Frankfort-on-Oder: It has already been said several times, especially by Herr Lindley, that the expression "dangerous" must be most strongly opposed. I would also say a word in that direction. We find ourselves constantly in a certain conflict with the hygienists, who as yet are not willing to allow the engineers their proper place; and if we ourselves call our work dangerous, we shall be giving our best weapon out of our hands. Is then the filter as it is used to-day really dangerous? I advance the proposition, that it is one of the safest appliances; no machine is so certain in its operation. A filter is really a very manageable thing when it is not too grossly mishandled and when it is not entirely wrongly constructed. It is remarkably free from liability to disturbance. The sand arranges and settles itself. If one takes off a little more or a little less; if one uses a little more or a little less loss of head, or a little higher or a little lower velocity of filtration, then all has a very small influence. But how is it with a machine? I can hardly believe that an electrical apparatus, let us say, would stand corresponding treatment without trouble. How do we know that the ozone will come to every single bacteria? The sand filter is much surer than a machine, and when we consider a sand filter dangerous, then is every apparatus into which machinery enters doubly and trebly dangerous. I would only add to that which has already been said that the ozone process should be regarded only as an annex and not as the principal apparatus.

Dr. Weyl has shown us that iron and air will not lead us to the mark, and that also ozone by itself is insufficient. In the description of the technical application of the apparatus, however, I have failed to find the iron included. Where does the iron come in, so that the good operation is sure?

Dr. Weyl then said: The iron ozone process is only intended for water which is very rich in organic substances, and thus for such waters which would best not be used for drinking water. In the purification of ordinary raw water by means of ozone in general no iron would be used. On the other hand, the iron ozone process would seem to be particularly adapted to the purification of sewage; but upon this point no experiments have yet been made. Peaty waters, of which I have previously spoken, allow themselves to be entirely decolorized by ozone, and all iron is removed from them.

Herr Lindley, Frankfort-on-Main: I would only like to put on record that we consider that the cases which Dr. Weyl has mentioned as evidences of the damaging effect of sand filters on the public health are not to be considered as evidence at all and that in all cases (as, in part, the author has himself indicated) they are examples of bad construction and should be charged to that and not to the process itself.

In regard to the organic matters, it has occurred to me that as the consumption of a large amount of ozone was for the burning of these substances, and as these substances in great part (often in greatest part) are in suspension, it would pay to first filter the water through sand to remove these substances, and then apply the ozone to the remaining bacteria and substances in solution. Certainly I have never thought, and have not said that it should be said to the ozone: "Here is the water. There is so much dissolved substance and so many bacteria in it. Go for the bacteria and kill them, but leave the organic substances in peace." Again I propose the question: Does Dr. Weyl believe that by the ozone process the purification, thus including the clarification of muddy waters, can be reached; or in other words, can it perform this important function of a sand filter? This question he has not yet answered. I stand, as formerly, in the position that we follow the experiments with the greatest interest; and that we should heartily thank the gentlemen who have had to do with them; and they can be assured that when they are in a position to apply them to our filtration works with the necessary advantages and surety, they will find us among their most grateful followers.

Dr. Weyl: I will only remark that turbidity is due to many different substances. It is in part inorganic matter. So far evidently the ozone will not attack it; and to remove this kind of turbidity a coarse filter will be

necessary. When the turbidity is of organic nature, the removal of it by destruction by ozone would be an unprofitable operation. Also in this case a previous filtration would be advantageous. It is strongly to be recommended, however, where possible, to avoid the use of highly turbid waters for city supplies.

To Herr Halbertsma I can only answer that I shall be glad to secure further information regarding the ozone process in foreign lands.

In the "Technologie Sanitaire" for Jan. 1, 1900, Director Adolph Kemna, of the Antwerp Waterworks, reviews the paper and discussion. He speaks of the experiments made by the author of the paper in connection with the firm of Siemens & Halske. The Siemens, he says, are known as scientists quite as much as manufacturers. Dr. Weyl has created a name for himself as a chemist, and is the author of an encyclopedia of hygiene; and we have thus all the elements of success if the system is capable of giving it. The paper with the full stenographic report of the discussion should give us a full idea of the situation, and of the progress which has been realized since the last work, which was published in the report of von Ermengen and Gerard upon the trials made by Baron von Tyndall at Brussels in 1897.

In the paper of Dr. Weyl there is an indication of a new process. He proposes to combine the action of ozone with that of metallic iron, and the results obtained are much more favorable than those with ozone alone. M. Kemna then quotes the paper and the discussion at length, and says:

Lindley's words are golden. We cannot sufficiently praise them. The eminent engineer of Frankfort-on-Main has re-said that which I have often written, almost in the same terms, and all the speakers who have followed him have insisted equally upon the efficacy of filtration. It was a characteristic remark of M. Schmetzer of Frankfort-on-Oder that the filter is a most certain appliance; that the sand takes care of itself; that its thickness may be varied considerably, as well as the head and rate without yielding bad results. To make it go wrong it is necessary to treat it very badly. It is the surest appliance. No machine is so constant and regular. It certainly would not be safer to replace such a certain appliance by an electrical ozone machine which may at any moment cease to operate and without being noticed.

M. Weyl has cited a number of epidemics caused by river waters which have been filtered. In 1889 the works at the Stralau Gate in Berlin gave rise to typhoid fever in the district supplied from them, and, according to him, for this reason it was necessary to close the works; but Director Beer has replied that the abandonment of the old Stralau filters was already decided upon before that time; and further that it is still contested whether the epidemic was really caused by the water. It seems to me that M. Beer has gone a little too far in this. The work of Frankel and Piefke at the time made it at least very probable that the water was at fault. They even went so far as to say which filter was at fault, and to determine that it was due to the effect of the continued deep frost upon the open filters, making it necessary for the others to be overworked.

In the same way the epidemic of cholera at Nietleben in 1892 cited by M. Weyl was due to the bad operation of the filters, as appears in Dr. Weyl's own hand-book.

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Let us await the results. Even if they are good, it will not do to run down the work of sand filters or to underestimate the great services which they have rendered. On the contrary, let us preserve most carefully their memory, even though we should replace them by a new system. The situation is happily such that there is no urgency. We are quite able to take our own time in the matter.

THE GRADE-CROSSING PROBLEM.*

By L. F. Loree.†

The responsibility for the creation of grade-crossings rests not unequally upon the State and upon the railroads. The identical location of tracks which are now regarded as inimical to the best interests of the cities were, in many cases, granted as inducements to railroad construction. For this purpose streets were vacated and rights of way presented through the centers of towns. The responsibility, therefore, is a joint one, and should be frankly acknowledged by all the parties interested.

In this country the first intelligent inquiry into the grade-crossing question was made by a commission appointed by the Legislature of Massachusetts in 1888. The commission classified the crossings as follows:

(1) Common country roads, having no buildings to be affected by any change which might be made. (2) Country roads with buildings near. (3) Village streets with rows of houses. (4) Tracks running through village squares. (5) City streets. (6) Where several city streets join nearby to complicate the problem and the traffic is heavy. (7) Cases where the crossings are complicated with canals or rivers or ponds in cities.

The law imposes upon every traveler, before crossing a railroad track, on the highway, to "stop, look and listen." It is worthy of notice that very seldom are children hurt at grade-crossings, even those in the vicinity of large public schools, and this is because of their timidity and almost invariable use of due caution. If the requirements of the law are observed, necessity seldom exists for further action in classes one, two, three and four, unless view of the track is obscured.

It is obvious, therefore, that the vast majority of crossings must remain unprotected; but this does not imply that they must remain unimproved. The degree of danger at such crossings depends upon the following conditions:

(1) The view of the railroad from the highway; the more nearly perfect and more extensive the view, the less the danger. (2) The character of the approach to the crossing, both of the railroads and of the highway, whether level or on a grade. (3) The number of vehicles and pedestrians on the highway, and the character of the travel thereon.

An observation of the use of a large number of crossings leads me to the conclusion that not until the number of vehicles and pedestrians upon the highway reaches 3,000 daily is it necessary to examine into the necessity of throwing additional safeguards around the crossing.

Where further safeguards are necessary, the simplest and least expensive is the installment of an electric bell or semaphore signal. Under proper inspection and maintenances these signals are effective as warnings to travelers. As the danger increases a flagman is usually installed; this safeguard is further augmented by the introduction of gates, which, when lowered, close the street for passage until the train has cleared the crossing; and we come, finally, to the last development, where the gates are worked from a tower raised to a sufficient height to permit the watchman to have an unobstructed view of conditions, both upon the highway and upon the railroad tracks; and there is stationed on the ground a watchman to assist by conscious intelligense and activity the mechanical appliance.

According to the Massachusettss Commission, nearly all railroad casualties are popularly ascribed to the existence of grade-crossings, whereas many causes contribute to such loss of life. It is the fashion to say that we cannot for a moment balance human life against monetary expense, but after all, safety, in any degree, is relative, and the facts ought to be carefully determined and the responsibility placed where it belongs.

Accidents to trespassers ought not to incite the public to compel the expenditure of vast sums to abolish crossings at grade. Nevertheless, circumstances may, in certain locations, make it advisable to separate the grades of railroads and highways.

When the conditions finally bring the State to a consideration of this necessity, the first step should be the prohibition of the creation of new grade-crossings. The next step should be the definite abandonment of a very large number of existing crossings. It would seem to be fair to all interests, and to work no hardship to the community to definitely abandon at least 33% of the street-crossings. In other cases a subway or bridge for foot passengers can only be substituted.

There remains then, finally, the full use of the street at a grade separate from that of the railroad. It has been the experience of other countries—and will be our experience here—that the interruption of traffic on important thoroughfares in the larger cities, especially near yards and stations, finally become unbearable and compels the separation of grades; and this inconvenience is, after all, the prime consideration rather than the alleged danger, which is slight and usually a mere pretext. The procedure varies with the topography of the district, the character and amount of the railroad and street traffic, and the improvements upon the adjacent property. Ordinarily the method of grade separation largely depends upon the character of these improvements, and may be classified into residential property, manufacturing property and railroad terminal property.

In residential districts it is believed that elevation of such a height as to cause but slight depression in street crossings is the best method. In manufacturing districts the street traffic, while important is not the paramount consideration; hence street grades may be steeper to permit a minimum elevation of tracks, so that connections to industries may be maintained. The appearance of the completed work, while not so pleasing as the style of construction recommended for residential districts, bears the stamp of utility. It has been the experience, however, broadly speaking, that track elevation has killed manufacturing districts.

In railway terminal districts the situation is vastly more complex than in either of the preceding classes. Passenger and freight terminals must be located as closely as possible to the centers of business; consequently they are surrounded on all sides by expensive improvements. If, as in Chicago, where there is maintained in the center of the city what is known as the viaduct district, the tracks are allowed to remain on the surface of the ground and the streets carried over on viaducts, then there are expensive property damages, expensive structures and bad grades on approach to freight yards. It is probable, however, that in terminal districts, the viaduct system of separating the grades of crossings imposes fewer restrictions than the other methods. In summing up I should say that in a residential district, track elevation has a beneficial effect on city property. It cannot be too strongly emphasized that it is impossible to maintain an industrial district unless the tracks can be kept on the surface. Railroad operation is benefited by abolition of the grade-crossings across or near terminal yards.

On the part of the railroad the interests involved in the abolition of grade-crossings are simple enough:

It will seek to minimize the total cost, and especially its proportionate part. It will seek to avoid the introduction of grades or of curves; the loss of property or arrangements that will make impossible expansion to meet the undeterminable needs of the future; details of construction, and especially the destruction of manufacturing districts, its most valuable reservoirs of traffic. Besides that cost, that can be closely estimated, there is the cost on account of property taken, or damages for property injuriously affected.

On the part of the cities, the interests are complex in the extreme. Few of the streams of modern civilization are so muddy as that of politics. In almost every public work there is a job, and the effort to fasten one on the work of the character under consideration, directly or indirectly, delays, and sometimes defeats, an agreement. The municipal corporation is subdivided. The sense of moral responsibility is usually entirely wanting in the municipal government. A city council, once told by its legal advisers that it is not bound by the acts of its predecessors, and has no power to bind its successor, divests itself of all moral responsibility, and sets no limit to its shameless lack of integrity.

The individual property owner favors, in a general way, the abolition of grade-crossings, but does not willingly submit to the most trifling personal loss or inconvenience. These several interests so act and react upon one another, and upon the proposed agreement, and so ramify, appear and disappear that not only do they make a solution difficult, but a mere realization of their existence is a powerful deterrent to action.

A division of the expense between the State—with its subordinate corporations—and the railroads, that puts more than half the expense on the railroads, is, in my judgment, grossly inequitable. Upon such improvements as the automatic couplers, the application of air-brakes, the gradual erections of interlockings at railroad crossings and junctions, and the installation of block-signals, the railroads will expend $775,000,000. Add to this sum $3,979,211,070, the estimated cost of abolishing the grade-crossings, and we must contemplate an almost totally unproductive investment of $4,754,211,070, or 44% of the whole present capitalization of all the roads now in operation in the country. Can we afford such an investment? I think not. Competition is no longer confined to the individual, nor even to the community; it has become national in its character. In the race for commercial supremacy, this nation is, at the present time, in the lead; and we must regard as a grave national peril anything that is likely to substantially increase the cost of transportation, as such vast investments must do.

After all, the railroad is a gentle apothecary. In four years, in the city of Cleveland, O., 4,820 people lost their lives through contagious diseases and from preventible causes, while only two people were killed on the grade-crossings of the Pennsylvania R. R., constituting one-third of all the crossings in the city.

When all the reasons that seem to make desirable the abolition of grade-crossings have been marshaled into order; when those are stricken out that have no existence in fact, and those are reduced to their true proportions that have been exaggerated; when we realize that the moving consideration is one of public convenience, and not one of public safety, we shall find that there will be but little work of this character for which we can find any economical justification.

THE REPORT OF THE COMMISSIONER OF PATents for 1898 gives us the following statistical information for that year: Number of patent applications, 35,842; patents issued, including designs, 22,267. Since 1836, when Patent No. 1 was issued on July 28, a total of 596,467 patents have been issued, with 28,113 designs, 11,646 reissues and 31,070 trademarks. The total receipts of the office in 1898 were $1,137,734, and the total expenditures were $1,136,196. Of the latter sum, $720,294 was for salaries, $41,030 for the Official Gazette, $74,100 for photolithography, and $10,310 for stationery. The total cash receipts from applications for patents, etc., were $1,025,254; while the other receipts came from subscriptions to the Official Gazette, $11,015, and for registration of labels and prints, copies furnished, recording assignments, etc. As showing the work of examination, the Commissioner says that over 620,000 American patents, etc., and about 1,200,000 foreign patents have been issued and must be searched over.

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*From an address delivered before the students of Rutgers College, New Brunswick, N. J.

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ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Entered at the New York Post-Office as Second-Class Matter.
Published every Thursday
at St. Paul Building, 220 Broadway, New York, by
THE ENGINEERING NEWS PUBLISHING COMPANY

GEO. H. FROST, - - - - - - - - - PRESIDENT.
D. McN. STAUFFER, - - - - - - - VICE-PRESIDENT.
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PUBLICATION OFFICE, 220 BROADWAY, NEW YORK.
CHICAGO OFFICE, 1636 MONADNOCK BLOCK.
BOSTON OFFICE, 299 DEVONSHIRE ST.
CLEVELAND OFFICE, OSBORN BUILDING.
LONDON OFFICE, EFFINGHAM HOUSE, 1 ARUNDEL ST., STRAND.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; 6 months, $2.50; 2 months, $1.00. To all other countries in the Postal Union: Regular Edition, One Year, $7.60 (31 shillings); Thin Paper Edition, One Year, $6.31 (26 shillings). SINGLE COPIES of any number in current year, 15 cents.

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The Department of State deserves and will receive the hearty approval of all intelligent citizens, whatever their party affiliations, for its notable achievements in securing European assent to the principle of the "Open Door" in China, and in negotiating a new treaty with Great Britain in place of the Clayton-Bulwer agreement, under which assent is given to the construction by the United States of a canal across the Central America isthmus which shall be neutralized by international agreement in the same manner as the Suez Canal.

In view of the energy which Secretary Hay and his associates have shown in this matter, there is every reason to believe the reports that his Department will at once undertake negotiations with Nicaragua and Costa Rica, to secure their assent to the direct construction of the canal by the United States. It must be clear to any one that much better terms can probably be obtained from these republics, while the location of the proposed canal is still, to some extent, an open question, than can be secured after Congress has passed the bills now pending which fix the Nicaragua isthmus as its location.

One of the most animated discussions on water purification that has ever come to our attention was precipitated recently by a paper on the treatment of water by ozone, by Dr. Theo. Weyl, read before the German Society of Gas and Water-Works Engineers. The author described some experiments with ozone, on a small scale, and in his enthusiasm for the process and his claims for its superiority over other methods of treating water he went so far as to say that slow sand filtration plants were one of the most dangerous public works operated by municipalities. Although this sentiment was uttered in perfect good faith, and with a friendly spirit, it proved to be most injudicious, and did far more to bring out the merits of slow sand filtration in the discussion which followed than to establish those of ozone. There were present many German and a few Dutch engineers, who have labored most assiduously and successfully to put filtration on a thoroughly scientific and practical basis. In view of their wonderful bacterial and hygienic results, and their ingenious and satisfactory devices for controlling the operations of filter beds, it is no wonder that these words of Dr. Weyl filled them with consternation, especially after they were just assuring themselves that they had silenced some of the bitter opponents to the theory that typhoid fever and cholera are essentially water-borne diseases, and had proven to the world that filtration would hold those diseases in check. Dr. Weyl strove pluckily to maintain his position all through the discussion, a full abstract of which is given elsewhere in this issue, but the friends of filtration showed that most of his arguments against the sufficiency of the process were based on either old and inadequate, or poorly operated works, rather than modern plants, while he really did not prove that, on a working scale, ozone would be any more efficient or reliable than filtration, to say nothing of the relative costs of the two processes. As to the latter, ozone treatment, as far as developed, seems to require previous filtration of the water, unless it is quite free from suspended matters. A very interesting point brought out in the discussion was that most of the plants for treating water with iron, in the Anderson revolving purifiers, have been abandoned, wholly or in part, because of inefficiency, and that they were generally adopted because local conditions made it difficult to obtain sufficient areas for sand filtration alone.

If the proposed consolidation of bridge building companies should be effected and should result in an abatement of some of the practices which have been more or less common in the highway bridge business, the public might gain rather than lose. The results of free competition in highway bridge lettings have been a great expenditure on the salaries and expenses of traveling agents, and not infrequently a competition as to which concern could pay the highest price to buy the favor of the public officials in charge of the letting. It is the taxpayers, not the bridge companies, which have had to pay these bills in the end; and any consolidation which can wipe out these needless expenditures can afford to divide with the public and still have left a large profit for itself.

NEW YORK'S CANAL POLICY. WHAT SHALL IT BE?

"I am very desirous of seeing the canal policy of the state definitely formulated," said Governor Roosevelt a year ago in appointing the advisory canal committee, whose report we printed in our last issue. As outlined in this column last week, the policy which has been formulated by this committee in response to the Governor's request is, in brief, the construction of a 12 ft. deep barge canal from Lake Erie to the Hudson River, adapted for boats carrying cargoes of 1,000 tons, at a total cost to the state estimated at about $60,000,000.

Will this plan be accepted by the dominant party in the state, and if accepted can they obtain the approval of the requisite majority of its voters? It must be understood that under the State Constitution the sum named as requisite can only be obtained by an issue of bonds, and such issue must be first approved by the legislature and then submitted to direct vote of the people. The leaders of the party at present in power in New York have had some sad experience with canal matters. They are well aware that the unfortunate outcome of the "nine million dollar" improvement came within an ace of defeating them at the last state election. They will make very certain the $60,000,000 appropriation meets with popular favor before they submit it to the people, especially in the same year that a President is to be elected.

As for the trend of popular sentiment, it is of interest to note that the newspapers of New York and Buffalo as a whole welcome the $60,000,000 project with enthusiasm. The cities along the line of the canal show rather surprising coolness, and intimate that New York and Buffalo should bear the whole expense since they will reap the chief benefit. In other parts of the state the sentiment is either hostile or neutral, as was to be expected.

The warm support of the enterprise comes, of course, from the commercial organizations and these figure so largely in the public prints and include among their members so many men of prominence that a rather exaggerated idea may be easily obtained as to the amount of public favor with which any such project as this is regarded. Were it a matter which the legislature alone could settle, it is entirely probable that the scheme would be carried through; but to ask the voters of the state to pass upon it, "there's the rub."

In our opinion, the farmers of the state, including even those in the "canal counties," will generally oppose any further expenditure on canal improvement. Even where the tax is not laid on them, they will vote against it on the ground that cheapened transportation aids the western farmer to compete with them in the local markets. Another large class who will vote against the project are city and village householders, and taxpayers who will object to the proposed increase in their burdens, small though it may be. There are also indications that a large proportion of the Democratic voters may oppose the appropriation in the belief that it would be spent by their political opponents, and would aid in building up the Republican organization.

The appropriation would be favored, on the other hand, by a large body of citizens on the ground of its commercial benefits and very generally by the laboring classes because of the employment it will provide for workingmen. The public opposition to railway corporations and the present tendency to favor state and municipal control and operation of public works will also have some influence in helping the project.

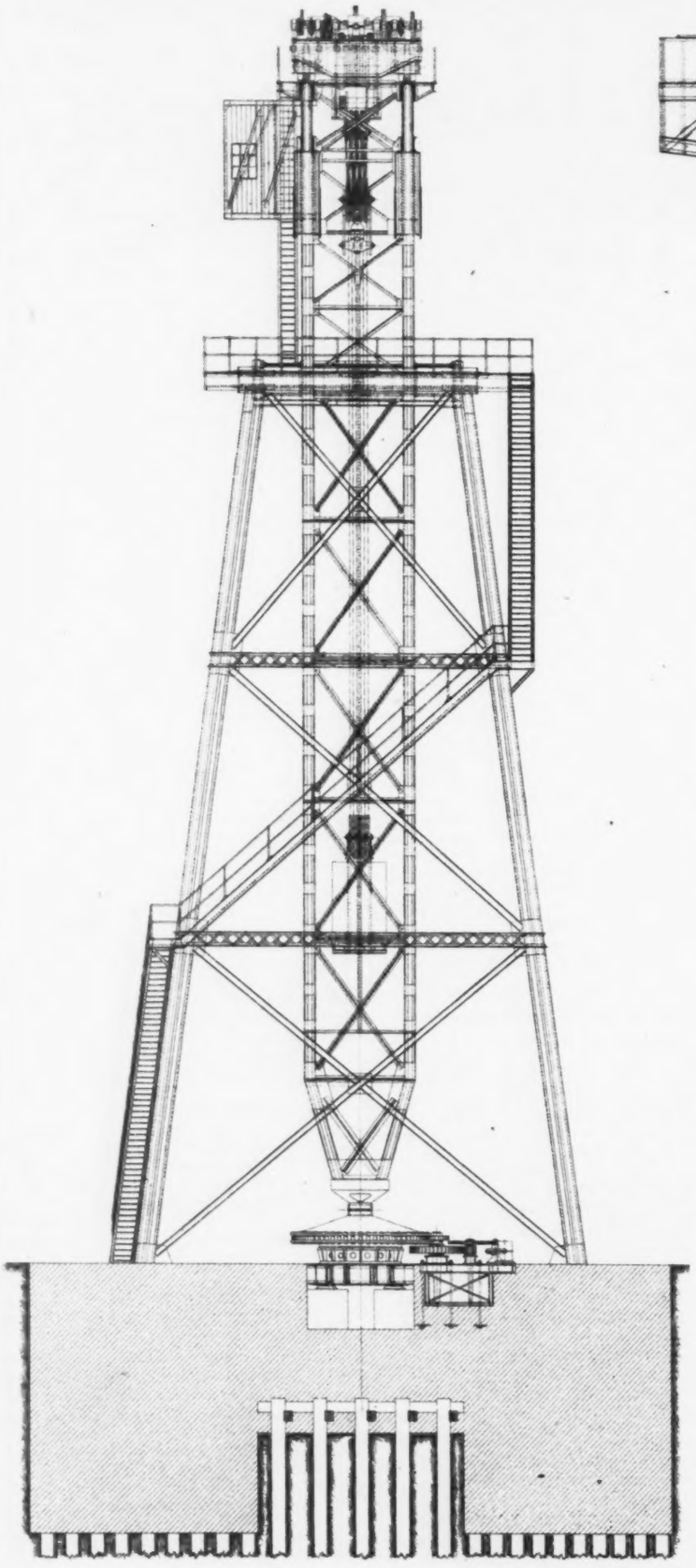
We present these facts that our readers may judge for themselves the probabilities as to New York's undertaking that "radical enlargement of the Erie canal," which has so long been a theme of discussion among engineers. Of course all this has nothing to do with the actual merits or demerits of the plan agreed upon by Gen. Greene and his associates, but the political aspects of the plan and the extent which it meets with popular favor must be considered in forecasting its success quite as much as its engineering and commercial features.

Turning now to these aspects of the plan, we freely admit that it is an attractive picture which the committee lays before the people. A barge canal moving a ton of freight a distance of 20 miles at a cost of one cent, and this cheap transportation turning a huge stream of traffic across the state of New York and building up along its course the greatest manufacturing and iron producing district that the world has ever seen. Add to this the spectacle of Father Knickerbocker exulting in a position in the export trade secure against all possible competitors, and it is small wonder that the commercial element in the state lends to the enterprise enthusiastic support.

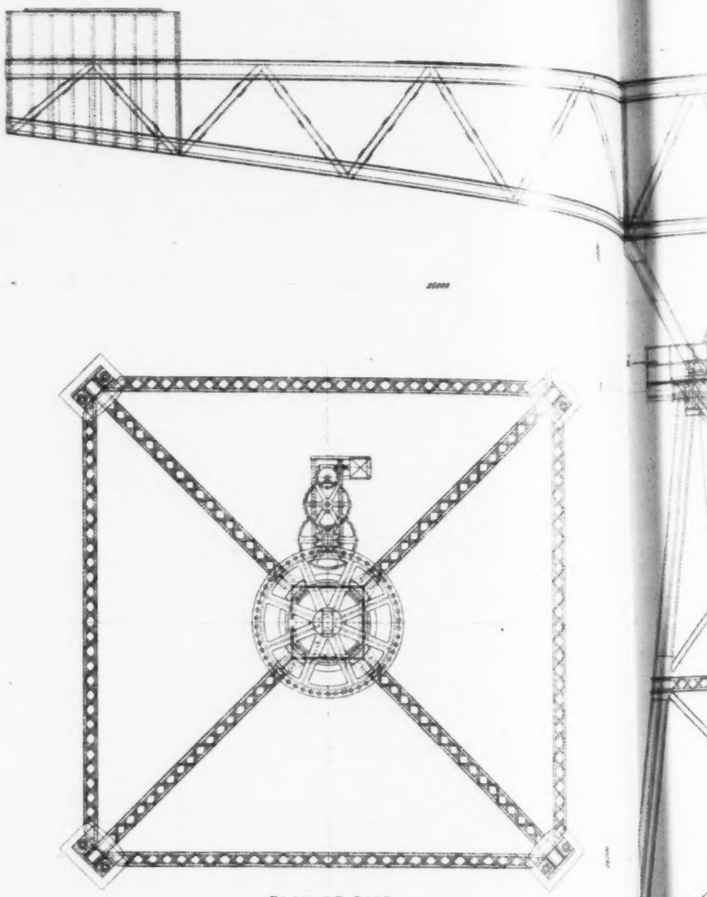
Before we join in the acclamation, however, we want to be more thoroughly convinced on certain matters.

First of all is the question of the cost of transportation by the new route. The Commission estimates this at 0.52 mill per ton mile; but it obtains this figure by omitting entirely that part of the cost of transportation which the state pays. It seems to us that this is false reasoning and bad financiering. The cost of making and maintaining the canal is just as truly a part of the cost of carrying goods upon it as the cost of building a railway and keeping up its tracks is part of the cost of moving freight by rail. No comparison of the relative cost of rail and water transportation can be considered fair unless the two are placed upon the same basis.

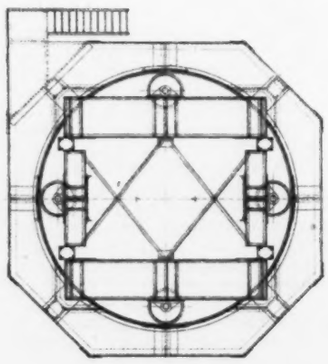
What would the cost of transportation be upon the $60,000,000 barge canal when the state's share of the expense is included? To answer this question, an estimate of the amount of traffic which the canal will obtain is necessary. The capacity of the canal is estimated by the Commission at 20,000,000 tons per annum; but the amount of traffic it can secure is another matter. We



END ELEVATION.



PLAN OF BASE.



CROSS-SECTION a-b.

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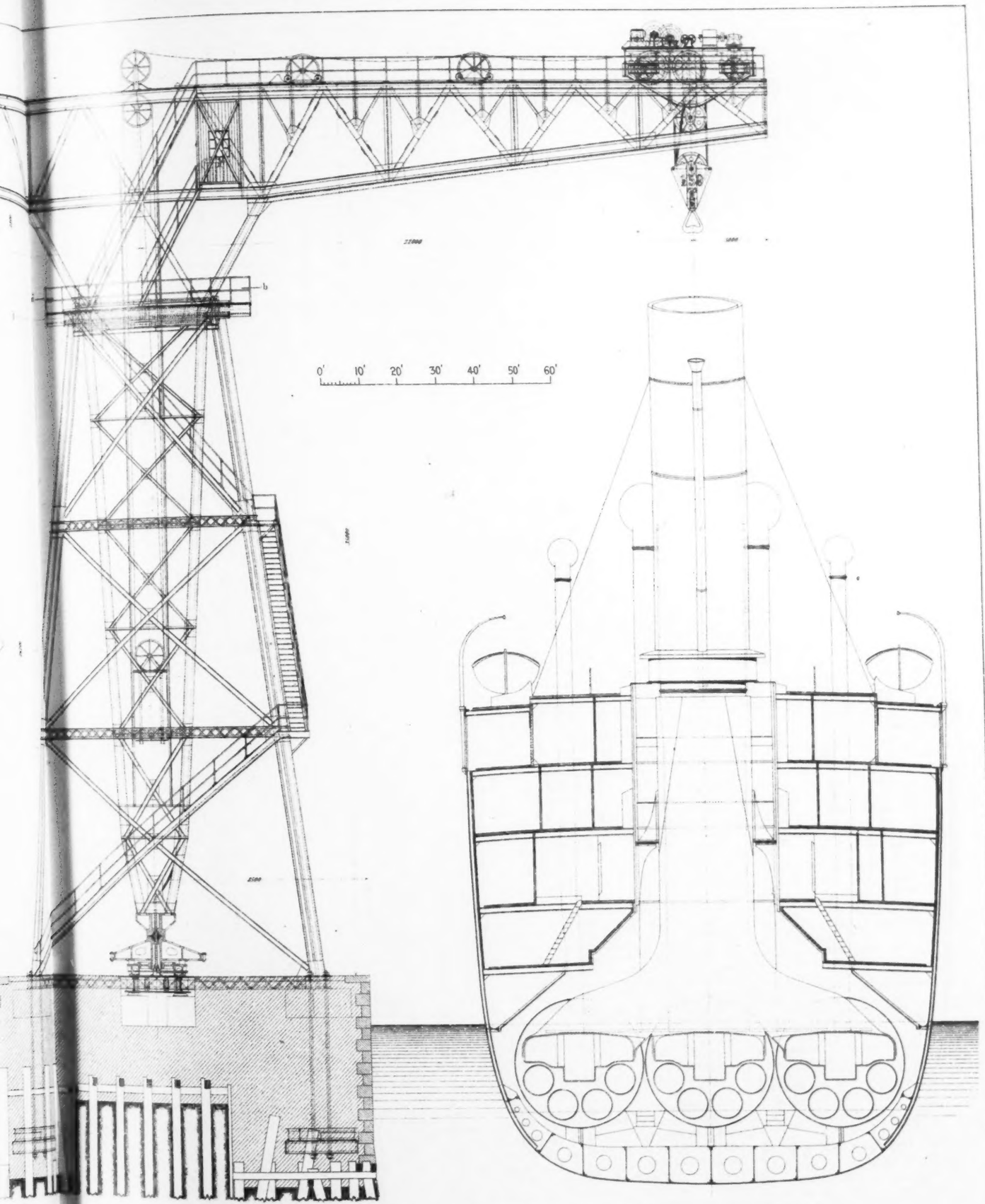
150 TON CRANE AT BREMERHA

Built at the Benrath Machine Works.



SECTIONAL SIDE ELEVATION WITH TRANSVERSE SECTION OF THE STEAMSHIP "KAISER WILHELM DER GROSSE."

AT BREMERHAVEN, GERMANY.

Machine Works, Benrath, Germany.

CHAS. HART, LITH., 25 VESEY ST., N. Y.

have seen many prospectuses of transportation enterprises in which future profits were computed on the theory that the new route would take the whole share of the business. In practice it never works that way. At best a new transportation route merely divides the business with its older rivals, and usually it has to be content with the smallest portion.

No matter what kind of a canal New York or the United States may build from the Great Lakes to the Ocean, the other rail and water routes to the seaboard will still remain open and continue to do business. The New York Central with its solid trains in which 80,000 bushels of grain are hauled by a single locomotive, the Baltimore & Ohio with its new equipment and improved roadbed, the Pennsylvania with its matchless organization for the economical handling of traffic, the lines reaching from the wheat and corn growing regions west of the Mississippi to the ports on the Gulf—all these, to say nothing of the Canadian rail and water routes to the seaboard, are in business to stay, and are bound to get their share of the traffic.

Some idea of the probable tonnage can also be gained by considering the present volume of traffic. The total receipts of grain and mill products at Buffalo, in 1898, were 7,021,000 tons; the total receipts of the same at New York, in 1898, were 4,900,000 tons. The proposed new canal, like the present Erie canal, would doubtless find its traffic in lumber, ice, coal, stone, and possibly iron ore, more largely than in the movement of grain and flour, and these low grade bulk freights might swell its traffic perhaps to 8,000,000 or possibly 10,000,000 tons per annum. A larger figure than this seems to us improbable.

Assuming a traffic of 8,000,000 tons, let us see what the state's share of the cost of carriage will be. Take the cost of the canal at $60,000,000; assume that the state pays interest on this at 3% and that 1½% additional should be charged for depreciation, due not only to actual deterioration of the canal and the structures upon it, but to the chance that after the lapse of years it will become obsolete.*

A charge of 4½% on $60,000,000 amounts to $2,700,000 per annum. Besides this, the state must pay the operating expenses, and the cost of repairs and maintenance. In 1898 the cost of "ordinary repairs and maintenance on the Erie canal was $513,432." Extraordinary repairs in the same year cost $765,700, or a total of $1,279,132. In view of these figures, the annual cost of operation and maintenance of an enlarged Erie canal, capable of handling a traffic of 8,000,000 tons per annum, can hardly be set at a less figure than $2,000,000. This would make the annual charge to the state $4,700,000, or about 60 cts. per ton of freight moved, on the above estimate of traffic. To this we may add the canal committee's estimate of the cost to the boatmen of 26 cts. per ton from Buffalo to New York, making a total cost for water transportation by the proposed canal of 86 cts. per ton.

To obtain the cost per ton-mile, the committee divides the total cost by the distance, from Buffalo to New York, 500 miles. This would not be correct for our present computation as the "average haul" on the canal would be much less than 500 miles. On the present New York canals, 55% of the traffic is "way freight," and probably this would be true of even a larger proportion in an enlarged canal with a traffic of 8,000,000 tons.

For these reasons we will assume an "average haul" of 400 miles for the traffic, and taking the average charge per ton as already found at 86 cts., we have the total cost of freight by the proposed waterway at 2.15 mills per ton mile, or about four times the figure given by the canal committee.

It seems to us that if a really fair and instructive comparison of the cost of rail and of water transportation is to be made, it must be by taking all the elements of cost into consideration in some such way as we have outlined. If, with this clearly understood, the state chooses to subsidize water transportation by assuming the burden of the fixed charges and maintenance it may do so, but the success of the water route in any such competition does not prove that it is really the cheaper system of transportation.

Although we cannot accept the conclusions of the Commission as to the economy of water over rail transportation, we acknowledge the courtesy and fairness with which it has treated the discussions of this subject which have appeared in the columns of Engineering News. In its volume of "Letters and Correpsondence" it has reprinted several of the editorials in which we have dealt with this matter, and it submitted them to the presidents of the Illinois Central, the New York Central, and the Pittsburg, Bessemer & Lake Erie railways, with request for their opinions upon the present and future cost of bulk freight transportation by rail. A direct reply to this question was hardly to be expected, for no president of a railway corporation cares to run the risk of having his official statement as to the cost of moving freight on his road quoted before a railway commission or a legislature which is considering the fixing of rates.

The replies of the two latter gentlemen, however, properly interpreted, seems to us to be in substantial accord with our position and we print them in full as follows:

Mr. F. V. Greene, Chairman Committee on Canals.

Dear Sir: Answering your inquiries in letter to Mr. Frick, I can probably do no better than to give you the results of our own operations. Our principal business at present is the transportation of ore in bulk from Conneaut Harbor to furnaces in the Pittsburg district. We do not have the back haul of coal and other products going north which we expect to have in the near future, and consequently our operations are unfavorable in that respect, the great volume of our loading being in one direction.

In the months of June, July and August, we transported 918,716 tons of ore 145 miles, earning 53 cts. per ton, or 3.65 mills per ton per mile; our ore trains average about 1,472 tons of paying load out of a total load of about 1,912 tons; our cost of transportation was in the neighborhood of 10 cts. per ton, to which should be added the cost of assisting engines over grades of 1 1-7 cts. per ton, making a total cost of 11.7 cts. per ton, equal to 0.8 of a mill per ton per mile. In consequence of returning the ore trains empty, there should be fairly added 10 cts. per ton to the cost, making total cost of 21.7 cts. per ton, equal to about 1.5 mills per ton per mile. This is figured upon gross tons of 2,240 lbs. In this cost is, of course, included the tonnage proportion of all the expenses of the road, including maintenance. We have a comparatively small amount of diversified traffic. Taking all freight, including ore, into consideration, the ton-mile cost during that period was about 1.4 mills.

Yours respectfully, J. H. Reed,
President Pittsburg, Bessemer & Lake Erie R. R. Co.
Pittsburg, Pa., Dec. 12, 1899.

Gen. Francis V. Greene, Chairman Committee on Canals.

My dear Sir: I have your favor of yesterday. It is very difficult to tell what the exact cost of transportation on a railroad is. Of course we can figure the cost on a certain number of cars, counting only the trainmen's wages, cost of fuel, and other moneys actually paid out; but the fixed charges, station expenses, track expenses, and a thousand and one things that enter into the general expenses of a railroad, are flexible, and depend so entirely on the volume of the business that it is impossible to estimate just what the actual expense is from time to time.

For example, we handled yesterday from 10,000 to 12,000 loaded cars on the system east of Buffalo. If this was reduced to 5,000 we would have to get a much larger rate; or if it were increased to, say, 15,000, we could do the work even cheaper than we are doing it now.

Our present plan is to renew our bridges, and build engines and cars which will transport from Buffalo to New York in one train about 80,000 bushels of grain. In connection with the large volume of other traffic, I have no doubt we will be able to carry grain from Buffalo to New York, including the elevation at Buffalo and the lighterage and port charges at New York, at an exceedingly low rate.

Yours very truly, S. R. Callaway,
President New York Central & Hudson River R. R. Co.
New York, Nov. 3, 1899.

Since the report of the Canal Committee appeared, Mr. Callaway has been quoted as saying that if the state of New York will pay the New York Central R. R. the interest on the cost of the proposed $60,000,000 canal, the railway will agree to haul free from Buffalo to New York all the grain that may be offered. He has also declared that whatever canal New York may build, the railways will still continue to carry the bulk of the traffic.

We need hardly say to our readers that this journal holds no brief for the railway companies in this discussion. Our sole object has been to ascertain and point out the most advantageous policy for the state of New York to pursue with reference to its routes of internal transportation.

After a careful study of the arguments presented by Gen. Greene and his associates in their report, we are still of the opinion that bulk freights can be moved across the state of New York more cheaply by a railway than by a canal, when all the elements entering into the cost of such transportation are considered. We freely admit that in case the costs of "conducting transportation" alone are compared, such a canal as the committee has proposed can probably move goods at less cost than the railway. But this advantage, we believe, is more than offset by the much greater first cost of the canal, resulting in heavier interest charges, and by the heavier cost of maintaining the canal.

We make this statement, however, in no dogmatic way, fully appreciating that the whole subject constitutes a comparatively untrodden field and one in which the wisest is liable to err. If the committee's estimates of probable traffic are not too sanguine and 15,000,000 tons or more can be secured by the proposed canal, then their contention as to the superior economy of the waterway over the railway would probably be justified. If, on the other hand, a traffic of 8,000,000 tons or less is all that can be obtained, the railway would be the cheaper system.

We fully appreciate, too, that the question cannot be considered from this standpoint alone. Even though the railway be the cheaper means of transport, and even though the competing railway lines continue to carry the bulk of the traffic, there is something to be said for a freight highway on which any competitor can move his vehicle and on which transportation cannot be monopolized. Until we reach some satisfactory basis for fixing railway rates, moreover, there is much to be said for a waterway whose potential and actual competition may serve as a limit to the charges of railway lines over a wide area of the country and which shall serve as a stimulus toward still better and more economical systems of railway operation.

It will be understood, then, that this journal does not oppose the barge canal proposition of Gen. Greene and his associates. While we are skeptical as to the measure of its success, and are inclined to the belief that a freight railway line from Lake Erie to the Hudson would be an enterprise on the whole more advantageous, the proposed barge canal would be a most interesting and important engineering work, and would afford profitable employment to a large number of engineers and contractors. Should the state of New York to decide to undertake the enterprise, we shall hope to see realized the most sanguine expectations of its originators.

*A sinking fund payment of 1½% per annum, placed at compound interest at 3% will equal the principal in 37 years.

LETTERS TO THE EDITOR.

The Plant of the Imperial Electric Light, Heat & Power Co., St. Louis, Mo.

Sir: In the abstract of my recent paper on the "Design and Construction of a Modern Central Lighting Station," published in your issue of Jan. 18, my name appears under Fig. 1 as the "Designing Engineer." I appreciate your kindness in endeavoring to place the credit with the proper parties, but do not want to be represented as being alone responsible for this work. My associate, Mr. Wm. H. Bryan, is entitled to equal credit.

The contractors for the building and station apparatus, the Arnold Electric Power Station Co., are also entitled to credit for the plans of many important details which were prepared by them under the supervision, and subject to the approval of Bryan & Humphrey, the Consulting Engineers for the Imperial Co. The National Conduit & Cable Co. were contractors for the conduits, and the Washburn & Moen Mfg. Co. installed the underground cables.

Yours very truly,
H. H. Humphrey.
Lincoln Trust Building, St. Louis, Mo., Feb. 1, 1900.

Concerning the Kenerson Extensometer.

Sir: In your issue of Jan. 25 you describe a very interesting recording extensometer produced by Mr. W. H. Kenerson, M. E., of Brown University, who is, no doubt, using it for purposes of instruction at that institution. In view of this latter fact, and because it is very unde-

When the great fill was complete, the trestles were removed in the work. The material for the fills was taken from cuts adjoining the work, and from the right of way near the ravine. Besides all the above-described work, there is a cut on the west side of the river 900 ft. long and 40 ft. deep.

The entire work has been done since last spring, and the whole cut-off is ready for the track, with the exception of the bridge. The pedestals will soon be ready for the superstructure. Mr. E. C. Cooley, M. Am. Soc. C. E., is Chief Engineer of the Chicago & Northwestern Ry., and Mr. W. C. Armstrong, of Boone, Ia., is Resident Engineer of the Boone County cut-off. For most of the information in the above article we are indebted to Mr. J. L. Graff, of Chicago.

It may be of interest to note here that last year a very high trestle on the Deadwood branch of the Chicago, Burlington & Quincy R. R. was filled in. The structure was 720 ft. long, with a maximum

Building Large Embankments on the Boone County Cut-Off; C. & N. W. Ry.
Winston Bros., Contractors.

height of 126 ft. The embankment was made 30 ft. wide at the top, and contains 310,000 cu. yds. of material. Steam shovels were used to excavate the material and load it on flat cars, the cars being fitted with hinged side boards. The earth was planed off with a Lidgerwood rapid unloader, and the work averaged 15 trains of 14 cars per 24 hours. At the steam shovel pit, there were long sidings for the use of the construction trains, and a telegraph operator was located at this point, so that little trouble was experienced in keeping the construction trains out of the way of regular trains. The work was finished in September last, and we are informed that up to the present time there has been no indication of shrinkage or settling of the bank. The contractors for the work were Kilpatrick Bros. & Collins, of Beatrice, Neb.

150-TON ELECTRIC CRANE AT THE IMPERIAL DOCK IN BREMERHAVEN, GERMANY.*

(With two-page plate.)

The huge crane which is illustrated on our inset sheet this week is the largest in the world. Although its lifting capacity is equaled by a few other machines, its gigantic proportions, enabling it to sweep over the loftiest steamship funnel, secure to it a pre-eminence among similar structures.

The design of the crane was determined by the location in which it is placed. It stands at the entrance to the repair dock close by the Imperial dock in the harbor of Bremen, Germany, and will be used for the installation of ships' boilers and other heavy machinery, and the fitting out of war vessels.

The superstructure of the crane is particularly worthy of attention. The arrangement, now used for the first time in a crane of this size, meets all demands for convenient and efficient operation, and the general design is well adapted to take care of external forces, and at the same time is pleasing to the eye. The suggestion to use this style of structure, which is more often adopted for machines of less range and capacity, is due to Herr O. Guenther, Engineer of the Mechanical Department of the Harbor Commission of Bremen.

The rigid supporting tower and the revolving mast or jib, which is supported at the foundation and at the top of the tower, form the chief parts of the structure. The supporting tower is built up of four corner posts with horizontal struts and diagonals, and diminishes in size towards the top. The bases of the corner posts are of cast steel, and are fastened to the masonry foundation by bolts or rods 23 ft. long and 4½ ins. in diameter. The top of the tower bears a built-up steel ring which serves as a circular track for the rollers on the mast (see Section a-b on the inset sheet). The mast itself is a frame-work structure, two sides of which are parallel to the plane containing the load, while the other dimension increases towards the top. It carries at the top a double-armed cantilever truss. The carriage with the hoisting gear runs upon the cantilever, and for the length of its course the cross or wind bracing is necessarily omitted. Its place is taken, however, by the framework of the foot-ways running along both sides of this end of the cantilever. The opposite end of the cantilever bears a counterweight, which is so proportioned that the negative bending moment arising from it when the carriage is at its inner position equals the positive moment due to a maximum load at the extreme length of the arm.

The total weight of the mast, counterweight and load produces a vertical pressure which is transmitted from the mast through a hinge to a revolving platform resting upon rollers. This latter platform bears a central pin passing through a collar secured to the foundations which, together with the rollers at the top of the supporting tower, takes care of the moment arising from the load or the unbalanced counterweight.

The upper roller bearing just mentioned consists of four pairs of cast-steel rollers, 39 ins. in diameter, the journals of each pair being carried on two horizontals connecting the corner posts of the mast. As may be seen from Section a-b on the inset, the designer has endeavored to make the diameter of the circular track as small as possible. The latter closely surrounds the mast, making it necessary to set in the horizontals on the two narrow sides. The rollers in the plane of the load are, of course, subjected to much greater pressure than the two side rollers, which are brought into action only by wind-pressure. The pressures are, respectively, 98 and 16 metric tons.

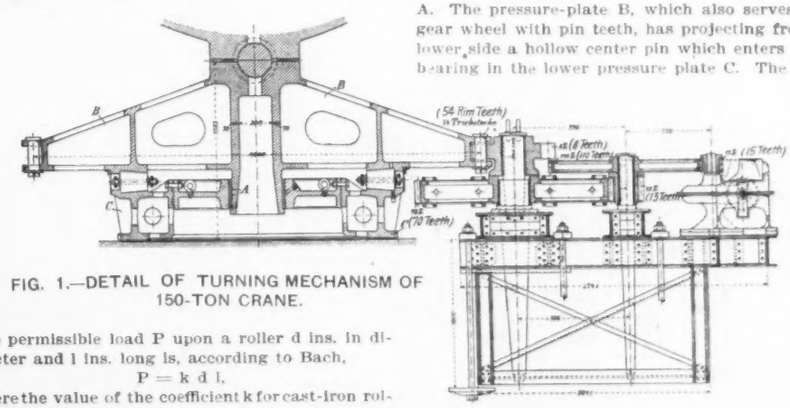


FIG. 1.—DETAIL OF TURNING MECHANISM OF 150-TON CRANE.

The permissible load P upon a roller d ins. in diameter and l ins. long is, according to Bach,

$$P = k\,d\,l,$$

where the value of the coefficient k for cast-iron rollers is 354 lbs., and for steel rollers and steel track 851 lbs. In the present case d = 39 ins. and l = 5 ins., corresponding to k = 539 lbs. for the heavily loaded rollers and k = 88 lbs. for the others.

It will be of interest to compare this structure with the 150-ton American crane with a swinging jib on a platform, recently described. (See Engineering News, Feb. 23, 1899.) The crane in Bremen harbor, in contrast to the American structure, is not stable of itself, but relies on an upward pull on its foundations in order to stand upright. From this fact there results a very substantial diminution of the total weight which must be turned, and the possibility is secured of supporting the total vertical thrust by a roller bearing, the mean diameter of whose track is 7¼ ft., as compared with 36 ft. in the American crane, thus reducing the work required to turn the structure nearly in the ratio of these diameters. The present arrangement also secures purely horizontal or vertical movements for the load, while with a swinging jib these can be secured only as resultant motions. It requires, of course, on the other hand, an extraordinary height for the cantilever in order that the latter may clear the superstructure and funnels of ships and avoid the tedious operation of shifting vessels about.

The total height of the crane is 118 ft. from the top of the foundations, and the total reach is 72 ft., giving a useful reach of 44¼ ft. from the front of the masonry wharf to the middle of the hook. An idea of these proportions may be obtained from the inset, where the North German Lloyd steamship, "Kaiser Wilhelm der Grosse," is shown, under the cantilever arm. The immersion of the vessel shown is less than that corresponding to full load.

The calculation of the members of the structure was made according to the rules laid down by the Bremen Harbor Commission, which required that the maximum stress, with 150 tons load and 21 lbs. per sq. ft. wind-pressure, and allowing for shocks, should never exceed 14,000 lbs. per sq. in. The stability of the crane was, moreover, calculated for a wind-pressure of 52 lbs. per sq. ft. perpendicular to the cantilever, in which case, also, the stress limit should not be exceeded. The test load was fixed at 200 tons. The frame-work is constructed of basic open-hearth steel of at least 59,000 lbs. per sq. in. breaking strength and 20 to 25% elongation.

We will commence the discussion of details with a consideration of the base of the mast and the turning machinery, which are shown in Fig. 1 to enlarged scale. The base of the mast carries a vertical thrust, which, with maximum load amounts to 580 tons, and a horizontal thrust due to the tipping moment, whose highest value from combined loading and wind-pressure is 86 tons. The vertical pressure is, as previously explained, carried by a set of rollers running upon a track of 87 ins. mean diameter. The conical rollers, 35 in number, are made of hardened steel and have a mean diameter of 6.9 ins., and a length of 9.8 ins. Their proper spacing is assured by bolts passing through them and secured to two rings, forming a containing frame. The value of the coefficient k of Prof. Bach's equation taken for these rollers was 525 lbs., as compared with the allowable 851 lbs.

The horizontal thrust is taken up by the collar A. The pressure-plate B, which also serves as a gear wheel with pin teeth, has projecting from its lower side a hollow center pin which enters into a bearing in the lower pressure plate C. The latter rests upon a steel grid, and between the two a 0.04-in. copper plate is inserted.

Lateral movement of the lower plate is prevented partly by wedges, but chiefly by frictional resistance. To secure a uniform distribution of the vertical pressure and at the same time allow for the unavoidable elastic distortion of the mast, a hinge is placed between the latter and the pressure plate.

The turning mechanism is actuated by a direct-current motor of 26-HP. at 550 revs. per min. A worm gear and gears and pinions transmit the rotation to the mast. The worm has two threads, and the worm wheel 30 teeth. The numbers of teeth on the different wheels in the transmission are noted in Fig. 1. The complete transmission takes place by the following ratios:

*Translated from the "Zeitschrift des Vereines Deutscher Ingenieure."

sirable that students should use instruments based on incorrect principles, and defective in design, I desire to review the construction of this recording extensometer and point out its shortcomings.

It is evidently intended to serve both as a practical as well as a scientific instrument. It fails in the former requirement because its applicability has a very limited range, and it can be used in tension tests only, and then merely up to the yielding point. It fails as a scientific apparatus, both as an extensometer and a recorder, because fundamental principles of design and behavior of materials have been disregarded. The instrument will not work correctly as a recorder, because the micrometers and the pen will not operate automatically in both directions, up and down. Those familiar with axial micrometric measurements, know that one or the other of the micrometers in many cases show negative readings, on account of apparent shortening of distance between points of contact, due to relative displacement of the upper and lower halves of the instrument, caused by unequal change of length of opposite elements of the test piece. This is not an actual shortening, but only an apparent one, caused by excessive strain on one side multiplied by leverage (distance) of micrometer from the axis of the test piece.

It is stated that the lower frame is attached at two points and the upper at three. This is wrong in principle. The object of using two micrometers is to obtain the true axial change of length of test piece, by measuring the average change of two opposite elements. In this design the upper frame is actuated by three elements while the lower is affected by two, none of which are necessarily in the same plane. Even neglecting other defects, this one is very serious. There is another defect which is bad in principle. Open elastic frames are used which may be sprung by the pressure of the clamping screws, necessary to hold the apparatus in proper position. As the pressure of these points varies during the test, due to diminution of size of test piece, the change of clamping frame will vary in proportion. This is particularly true of the upper frame, which is very heavy for such instruments, carrying not only the micrometers, but also the revolving cylinder and the actuating weight and its frame. A clamping frame having three attaching screws is, moreover, defective in principle, because two of the points must always be bent by the pressure applied by the third, which is the binding screw. All of these points affect the accuracy of the micrometer readings very materially.

The fundamental principle on which clamping frames of all instruments used on test pieces must be designed is this: "The necessary force to secure the instrument firmly must remain constant, or nearly so, and should not tend to produce deformations of the clamps or of the connecting parts." Examination of the design presented does not comply with either of these requirements.

Besides this, the connections of the upper and lower ends of the micrometers are not positive, and by no means avoid the possibility of play and lost motion. A further point to be considered is the speed of change of length, which, because of inertia of actuating weight and large micrometer heads, may seriously affect the actual motion of the micrometers, which is resisted by spring-cushions in the sockets, provided for the purpose of avoiding injury to the micrometers under the conditions stated. Now the rate of change of shape of many materials is nearly uniform up to the proportional limit, when it increases rapidly, until the yield point is reached; at this instant there is a sudden and much more rapid increase. These varying conditions must seriously affect the accuracy of the instrument.

All of these apparent defects in design and action cause me to raise a protest against the use of this instrument in an institution of learning, unless the most careful calibration has revealed all existing errors, for which allowance can then be made. My protest is made with a feeling of some assurance, because methods of avoiding and eliminating these defects have been used by many able investigators, and are especially described by Prof. A. Martens in his "Handbook of Testing Materials."*

Yours truly, Gus. C. Henning.

220 Broadway, New York, Jan. 26, 1900.

*John Wiley & Sons, N. Y.

(A proof of the above letter was submitted to Prof. Kenerson, and we have received the following reply.—Ed.:)

Sir: Mr. Henning's gratuitous assumption that an untried instrument of unknown utility is being used for purposes of regular instruction at Brown University has no foundation in fact. The instrument has up to the present time been undergoing a careful series of tests to determine its precision. Contrary to Mr. Henning's assumption also, the instrument is intended simply as a scientific instrument of a rather narrow range of application.

The description of the instrument in your issue of Jan. 25 was intended mainly to present an original method of securing the stress-strain diagram and not as a complete description of all the details of the extensometer. But even in the absence of complete description and drawings a careful perusal of the original article ought to have rendered much of the sweeping and somewhat hasty criticism unnecessary.

Some difficulties have been met and overcome in the trial of the extensometer; but during nearly a year of careful tests under various conditions, none of the numerous alleged defects which have called forth Mr. Henning's rather vigorous protest, have as yet appeared.

Detailed information in regard to the instrument will be gladly furnished at any time, but the main object in taking advantage of your courtesy is not to champion the instrument, but to refute the unwarranted assumption that the instrument is being thrust upon students without having undergone adequate tests.

Yours truly, Wm. H. Kenerson.

Brown University, Jan. 31, 1900.

THE DYNAMOMETER CAR now being built at the Burnside shops of the Illinois Central R. R. will be operated jointly by the railway company and the Department of Railway Mechanical Engineering of the University of Illinois. It will be equipped by the university with special apparatus and instruments for road tests of locomotives, air-brake, air-brake tests, and track inspection, as well as for dynamometer work. The car will be 45 ft. 6 ins. long over all, and 9 ft. wide, with a working space of 26 × 8½ ft., devoted to the testing apparatus. There will also be sleeping accommodation for six persons. The dynamometer recording apparatus will be similar to that now in use on the car operated by the University on the Peoria & Eastern Ry. (C., C., C. & St. L. Ry. system), but will be capable of heavier work. Instead of one drawbar cylinder, as in the present car (Eng. News, Nov. 24, 1898), there will be three tandem cylinders, 3, 6 and 9 ins. diameter. By combinations of these, the apparatus can be used for making tests with any train, from the lightest passenger to the heaviest freight train. The track inspection apparatus in the new car will automatically record deviations from gage and level of rails, and of superelevation of rails on curves, time, distance, etc. This is accomplished by transmitting, by means of oil, the motions of an independent pair of wheels under the car to small cylinders in the car. The pistons in these cylinders follow the motions of the wheels below, and their piston rods carry the pens by which the records are marked on a moving sheet of paper. This arrangement is somewhat the same as in Mr. Dudley's dynagraph car. The design and equipment of the new car above described were worked out by Mr. William Renshaw, Superintendent of Machinery of the Illinois Central R. R., and Prof. L. P. Breckenridge, Professor of Mechanical Engineering at the University of Illinois.

THE PHILADELPHIA COMMERCIAL MUSEUM is the subject of a bill presented to Congress by Representative Bingham, and referred to the Committee on Interstate and Foreign Commerce. This bill appropriates $200,000 for the purpose of completing for the museum the collections from foreign markets of samples of merchandise in demand in these countries, and for showing how such goods should be prepared and packed, and for collecting data useful to American manufacturers, merchants and producers. All the information thus collected is to be distributed free to boards of trade, chambers of commerce and other trade organizations in the United States. The claim of the museum is that its work has become national in furnishing American manufacturers with the latest information concerning openings for American trade; that it is a well-organized and well-conducted institution, and that its usefulness is acknowledged by the class of producers it was instituted to benefit.

A TELEPHONE SUBWAY TUNNEL is being built in Chicago by the Illinois Telephone & Telegraph Co., which proposes to install a new telephone system. The main shaft is at the rear of 170 Madison St., and is 35 ft. deep. The tunnel runs along under the alley between Madison and Monroe Sts. to La Salle St., and then under this latter street, both north and south. The La Salle St. portion of the tunnel is now 800 ft. long, and its average dimensions are 8 ft. in height and 5 ft. in width. Small dump cars carry the excavated dirt from the headings, and are hoisted up the shaft, discharging the material into a belt conveyor for loading the wagons which remove the material. The rate of progress is said to be 150 ft. per day. The tunnel is lined with concrete, and is being built by the company by day labor, instead of by contract.

A TRANS-ALASKAN RAILWAY is reported upon by Capt. W. R. Abercrombie, U. S. A. This military route would connect Port Valdez, Alaska, and Port Egbert, on the Yukon River. Starting from Valdez, the exploring party passed up the valley of Lower River with a nominal grade, and through Keystone Canon, with ordinary work, and emerged on the foot-plain of the inner canon basin. From the latter point they found two feasible routes; one east of Marshall Pass, crossing at an elevation of 1,700 ft. and then going down the Tasnuna to the Copper River Valley. The other route turns north, crosses [illegible] mountain at Thompson Pass, with an elevation of [illegible] ft., and thence down the Telkhell River valley, through the swampy pass at the head of the Knata and down the Tonsina to the Copper River valley. Valdez is 1,250 miles from Seattle; but there is an unimpeded ocean passage between these points, which practically [illegible] the double insurance rates on the 1,050-mile inside passage to Skagway. The direct line from Valdez to Port Egbert is 310 miles, and the railway would probably be [illegible] miles long. The estimate is $753,500 for a 3-ft. gage road, or $22,531 per mile.

MUNICIPAL OWNERSHIP OF THE WATER WORKS of London is recommended by the Royal Commission, appointed in May, 1897, with Lord Llandoff as chairman. The committee has just made its report. It recommends that the works of the eight companies now supplying London be acquired by agreement or arbitration, the cost to be met by an issue of 3% bonds. The commission is against entrusting the management of the consolidated works to the London County Council. It urges that "the water board should be a permanent and not a fluctuating body; consisting of not more than 30 members selected on account of their business capacity, and if possible their knowledge of matters connected with water supply; and so constituted as not to give a preponderance to any of the conflicting interests concerned." It proposes that the London County Council appont ten members of the water board, the Conservators of the River Thames, four, and a number of county councils and other bodies, two each; while their Local Government Board would appoint the chairman and vice-chairman.

BUILDING LARGE EMBANKMENTS ON THE BOONE COUNTY RY. (C. & N. W. RY. SYSTEM.)

The Boone County Ry., in Iowa, is a cut-off or short line now being built by the Chicago & Northwestern Ry. This line extends from Boone to Ogden, on the Iowa Division, and will be 7.4 miles in length. It will effect a saving over the main line of three miles in distance, according to the railway company's annual report, and will also effect important improvements in grade and alinement. On the present line, through Moingona, there are 902° of curvature, and a maximum grade of 1.5%, while on the new line there will be but 68° of curvature and a maximum grade of 0.5%. On this line will be a double track steel bridge 2,085 ft. long and 185 ft. high (Eng. News, Nov. 30, 1899) across the Des Moines river and valley. This will consist of viaduct approaches and a deck structure spanning the river. The cost of the bridge will be about $600,000, and that of the entire line will be about $1,000,000. The line will be double track throughout.

The bluffs forming the valley are so high and steep, that it was necessary to build, at considerable expense, an incline railway, on which to lower the cut stone of which the foundation pedestals for the viaduct are being built, these pedestals extending some 30 ft. below the surface. The engineering force of the company is said to have spent five months digging wells across the valley by which the underlying material was fully determined before work on the costly structure was commenced.

Besides this great viaduct or bridge across the Des Moines River valley, the company has crossed two deep ravines with embankments containing 116,000 and 107,000 cu. yds. of earth, respectively. The contractors on this work (Winston Bros., of Minneapolis, Minn.), adopted a plan by which the dumping at the start was made to spread the filling material over the entire width of the right of way. Two lines of trestles, 80 ft. apart, were constructed across the ravine. On each side of each line of trestle was a bench or shoulder 10 ft. below the top of the trestle. A track was laid along each shoulder, and on each of these tracks ran an inclined chute or apron, one-half of which was double the length of the other half, the two parts being separated by a vertical partition. The top of the apron reached to the top of the trestle, as shown in the accompanying cut. On top of the trestle was a double track on which dump cars were operated. Cars dumped over the long side of the apron would form one ridge, while those dumped on the shorter side of the apron formed another ridge closer to the trestle. There being two lines of trestles, with aprons on both sides of each line, and each apron making two different ridges, the result was that the embankment was built up by filling in eight parallel ridges of earth.

these two spindles are four pairs of gears, the ratios of which are nearly as follows: 1:6, 1:3, 1:2, so that a load equal to 1-9 the maximum can be handled with the full power of the motors. In order to set the gears it is necessary for the attendant to mount upon the carriage. By turning the hand-wheel H he moves the rod T, which, through a lever, shifts the two gears upon the corresponding end of the driving spindle. When the wheels belonging to one rod are out of gear it is locked by a bolt and the other rod is left free.

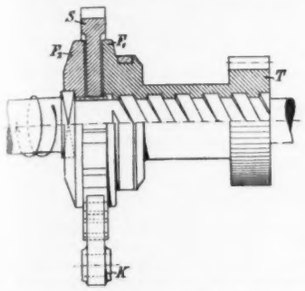


Fig. 5.—Detail of Mechanical Brake.

The lifting velocity for the maximum load is determined as follows: The motor makes 450 revs. per min. This is reduced as follows:

$$450 \cdot \frac{38}{135} \cdot \frac{13}{78} \cdot \frac{20}{64} \cdot \frac{13}{54} = 1.38 \text{ revs.}$$

per min. The mean diameter of the winding pulley is 50 ins., and the tackle has a ratio of 1:8. For the full load of 150 tons this gives a velocity of 27 ins. per min., and, using the change gears., for 75 tons 54 ins., for 37 tons 121 ins., and for 18 tons 21 ft. per min.

The braking arrangements are quite important. There are two of these provided, the electro-magnetic brakes, before-mentioned, and mechanical brakes, all working automatically. The magnetic brakes act upon the armature shafts of the motors and will prevent any disastrous results that might follow a careless handling of the switches or an interruption of the current. As long as the motors receive current, the brakes are released, but as soon as the current is cut off they are thrown into action and hold the load in suspension.

The mechanical brakes are arranged in duplicate upon the third spindle. They act as a reserve in case of the failure of the magnetic brakes and guard against any break in the first two spindles. Primarily, they are intended for the lowering of the load. Their manner of working may be seen from the schematic drawing in Fig. 5. Upon the driving shaft a thread of large pitch is cut, whose direction is so taken that the driving-wheel T, which is connected with the disk F_1, is driven against the ratchet-wheel S, and the second disk F_2 under the action of the load. The disk F_2 is held by a square hub on the shaft and moves with it. The wheel T is thus coupled to the shaft, and this takes place whatever the direction of rotation of the latter, that is, with both raising and lowering of the load. When winding up, the dog K which engages the ratchet-wheel S is automatically forced out, and the brake acts like an ordinary friction coupling. If, however, the load begins to sink, the ratchet-wheel is held fast and motion takes place between it and the disks F_1 and F_2. Now the pitch of the thread, upon which the pressure between the disks depends, is so chosen that the moment due to friction is greater than that due to the load. To make lowering possible this pressure must be relieved, that is, the shaft must be driven from the motor side in the direction corresponding to lowering, which is done by reversing the motors. The energy set free by lowering the load is then taken up in friction between the disks. The motors require only enough electric energy to overcome the friction of the gears and spindles on the motor side of the brake. When the motors are taking current, it will be remembered, the magnetic brakes are released. The velocity of lowering is dependent on the speed of the motors and, as they are lightly loaded, this is higher than the normal. The efficient operation of the brake depends, as will be evident, upon the right choice of the relation between the pitch of the screw and the friction surfaces.

The arrangement of the hook and block-and-tackle may be seen from Figs. 2 and 4. The hook is really a link, and is jointed in two planes and rotates easily upon a ball bearing containing fifty-nine 0.98-in. balls arranged in two rows.

The movement of the carriage is brought about by the motor M_3, which develops 26 HP. at 550 revs. per min. The carriage rests upon four pairs of wheels, only the two upon the right side being driven. Rotation is transmitted to these by a worm-gear and two pairs of gear wheels. The worm has one thread and the worm-wheel, 24 teeth. The complete transmission is in the ratio

$$\frac{1}{24} \cdot \frac{11}{26} \cdot \frac{12}{37} = \frac{1}{175}.$$

The speed of the wheels is then, $\frac{550}{175} = 3.14$ revs. per min. Their diameter is 31½ ins., so that the speed of the carriage is 26 ft. per min.

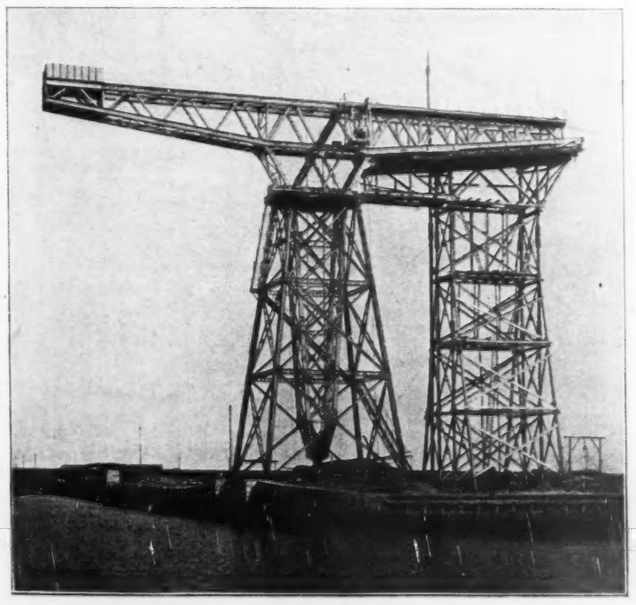


FIG. 6.—A VIEW DURING THE ERECTION OF THE 150-TON CRANE.

The motors operate at 110 volts. They are similar to street-car motors, with iron-clad fields, the commutator being accessible by means of a door. The power is obtained from the neighboring power-house, which furnishes current for the operation and lighting of the Imperial docks. The cables are carried up on the supporting tower above the rollers where the current is transferred to the cantilever through slip-rings. From these the cables go direct to the operator's cage. The latter is attached to the side of the cantilever, where the operator has an unobstructed view of the field of operation. The movements of the handles of all of the controllers correspond to the motion of the hook, making the operations very simple and decreasing the liability to error.

The weight of material required in the construction of the crane is given in the following summary:

Supporting tower and cantilever	602,492 lbs.
Turning machinery	104,852 "
Cable and blocks	6,785 "
Carriage and pulleys	109,666 "
Total	823,794 lbs.

823,794 lbs. = 411.8 tons.

The weight of the American 150-ton crane referred to for comparison is 775 tons.

The construction of the crane has been carried out by the Benrath Machine Works, of Benrath, Germany, who in turn sublet the structural work to the Gutehoffnungshütte, of Bochum, and the electrical work to the Union Elektrizitäts-gesellshaft, of Berlin. The supervision of the work rested with the Bremen Harbor Commission.

METHODS OF TESTING BLOWING FANS.*

By R. C. Carpenter, M. Am. Soc. M. E.

The following paper is a supplement to the one presented to the Society at its last annual meeting (Eng. News, Feb. 2, 1899), and is intended to call attention to certain difficulties experienced in the testing of blowers.

Object of Test.—The object of the test made on a blowing fan is, in nearly every case, the determination of the capacity of the fan either to move a given volume of air or to produce a certain pressure, or the determination of both of these qualities; also the determination of the power required for moving a given quantity of air under a certain pressure; and, finally, the efficiency of the fan. From complete tests as outlined above can be determined the economic value of different forms, and usually the costs of moving certain quantities of air under given conditions.

The measurement of the power required to operate the fan can generally be made with accuracy, although the method used will depend upon the character of the power.

The volume and weight of air delivered by the fan is almost invariably obtained by measuring the velocity of the air, and from this, computing the volume and weight. With the average velocity known, the volume is readily computed by multiplying the velocity by the area of cross-section through which the air flows. The weight is computed by multiplying the volume or number of cubic feet by the weight per cubic foot, which is to be obtained from tables prepared for such uses. The measurements of velocity of the air are usually made with the anemometer or the Pitot tube.

The anemometer is a delicate instrument, and its continued use is liable to increase the friction of its working parts and cause variation; for this reason it should be calibrated from time to time.

The velocity of air moving through a duct of a given cross-section can be computed by measuring the amount of heat required to warm the air through a certain number of degrees. This may be done as illustrated in the accompanying diagram. A duct, A, B, C, D, is supplied

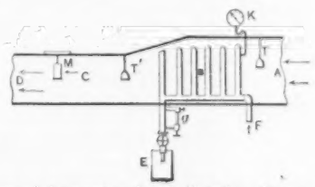


Diagram of Apparatus for Calibrating Anemometers.

with air by means of a blower located in some convenient position. A heater is placed in one end of this duct, the anemometer to be tested is placed beyond the heater, and arranged so that successive readings may be taken at all portions of the cross-section; the stopping and starting

*Condensed from a paper read at the New York meeting of the American Society of Heating and Ventilating Engineers.

$$\frac{2}{30}\cdot\frac{15}{110}\cdot\frac{13}{70}\cdot\frac{8}{54} = \text{about } \frac{1}{4{,}000}.$$

The cantilever makes, then, $\frac{550}{4{,}000} = 0.137$ rev. per min., or a complete revolution requires 7.2 mins. The circumferential motion of the hook at the extreme position is, therefore, 31½ ft. per min., and this is accomplished even with a maximum load. With a smaller load or a more favorable adjustment of the moment of the load and counterweight, the speed of the series motor rises correspondingly. The maximum pressure on the teeth of the last wheel in the transmission at starting, considering friction, wind-pressure and forces of acceleration, is about 52,800 lbs.

The armature shaft of the motor and the spindle of the worm are joined by an elastic coupling.

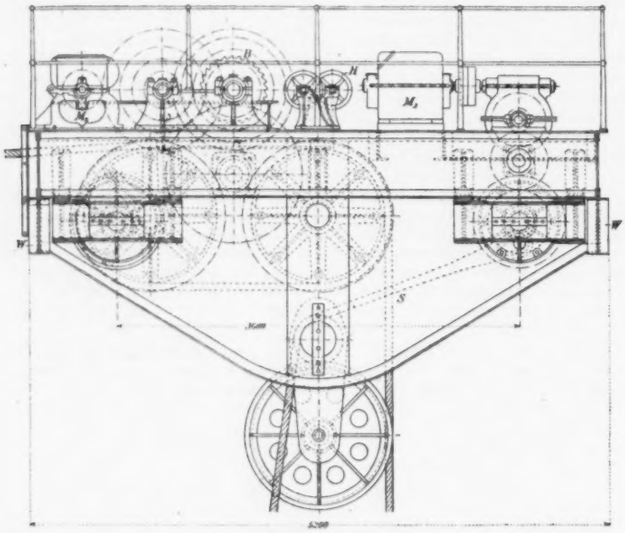


Fig. 2. Side Elevation.

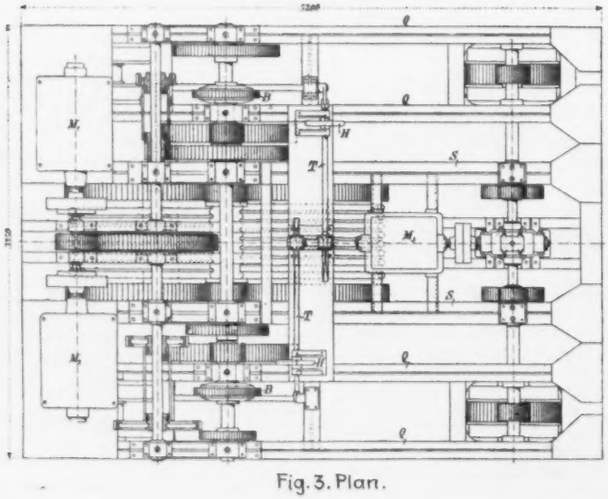


Fig. 3. Plan.

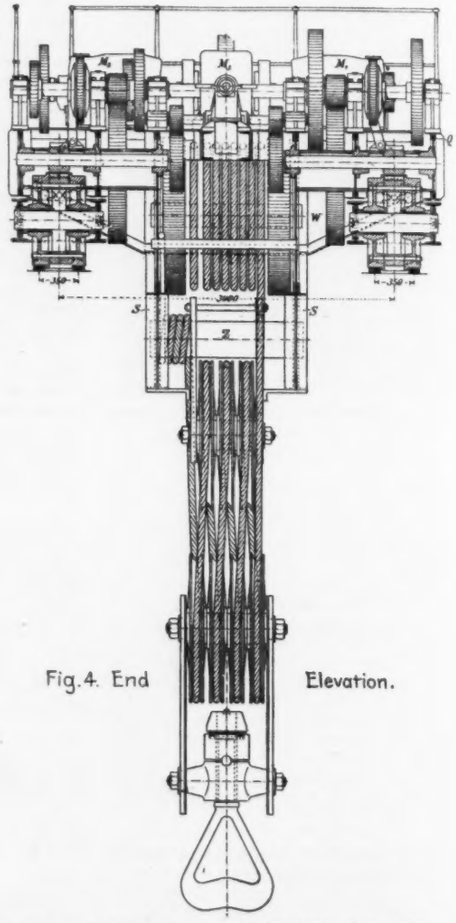


Fig. 4. End Elevation.

FIGS. 2 TO 4.—DETAILS OF CARRIAGE AND TACKLES.

The worm wheel is of bronze, and the remainder of the gears and the pressure plate of cast steel. The hubs of the wheels are provided with babbit boxes, which turn upon fixed axles held by a steel frame-work.

The carriage and lifting-tackle are shown in Figs. 2, 3 and 4.

The steel cable employed is of 2.36 ins. diameter, and has a breaking strength over a pulley 47¼ ins. in diameter of 150 tons. The tackle-block has seven sheaves, corresponding to eight plies of the cable. The stress on the cable is made up as follows: load, 150 tons; block, 5½ tons; cable, 2¾ tons; total, 158¼ tons. The advantage of the sheaves is taken $= 0.96 = 75\%$. By flexure over the sheaves and drums the cable loses 20% of its strength, leaving the load per ply $\frac{158.25}{8 \times 0.75 \times 0.8} =$ 33 tons, which corresponds to a factor of safety of 4½.

A windlass was chosen instead of a drum, as it did not seem practicable to wind the unusually long cable upon a drum borne by the carriage. In order to avoid shoving the cable upon the barrel and to make possible the use of grooves upon the latter, two barrels or pulleys were provided, which in their action correspond to a single pulley encircled an equal number of times. The number of turns is six, and the calculated necessary tension in the cable as it leaves the last pulley is 16 lbs. The loose end runs upon supporting rollers to the middle of the mast, where it is taken care of by a pair of blocks, through which it makes 12 turns. The lower block is weighted and runs between guides formed by two T-irons. This weight produces a tension of 1,100 lbs. in the cable, which is 68 times the 16 lbs. demanded. Both supporting rollers are attached to the carriage by chains in such a way that they recede before it when it moves inward and follow it outward. The inward travel of the carriage is limited by buffers.

The general arrangement of the carriage is evident from the figures. At the left is the lifting mechanism with the motors M_1 and M_2, which lie in the same axis. The motors and the greater part of the machinery are arranged upon the platform of the carriage, where they are easily accessible to the attendants.

In order to comprehend the construction of the carriage we will follow the way by which the forces due to the load are carried to the wheels of the truck. The tension of the fixed and loose plies of the cable are taken up by the pulley Z and the axle of the upper block, and are transferred to the heavy double beam S, which is supported in the middle. This is supported by the end pieces W. The outer ends of the latter are supported by the two beams Q, the upper surfaces of which are level with the top of S, forming with it the platform of the carriage. This structure is supported by four pairs of wheels, each of which has a separate frame. In order that both wheels of each pair may be equally loaded, the main structure rests upon them through flexible hinges.

The motors, M_1 and M_2, which operate the lifting tackle, are series-wound and deliver each 17½ HP at 450 revs. per min. They operate upon a common spindle to which they are connected by flexible couplings. The disks of these couplings serve as brake-disks for the electro-magnetic brakes which are controlled by the same current that passes through the armatures. From this spindle the rotation is transmitted over two sets of gears and pinions to a third spindle, which lies between the two cable pulleys. Upon this spindle are two pinions which engage with four gears bolted to the pulleys, thus securing four points of contact and a very safe construction.

It is important for any such large crane that it should, also, be adapted for light work, as the maximum load will be a rare exception. The motors will increase their speed with removal of the load, but only, at best, inversely, as the square root of the latter and, actually, on account of the saturation of the field-magnets, at a lesser rate. The American crane above referred to is, therefore, provided with an auxiliary tackle operated at a smaller reduction, and this is the course usually adopted by the Benrath Machine Works. In the present instance, in the attempt to harmonize size and speed, they have gone somewhat further. The ratio of transmission between the first and second spindles can be changed within wide limits.

mechanism is arranged so as to be operated from the outside of the box. One or more thermometers are located at T T′, thus permitting the measurement of the difference in temperature of the air. Dry steam is supplied the heater at F, and the water of condensation is drawn off at E, being maintained at a constant level by aid of the gage-glass g. Every pound of steam at known pressure and quality contains an amount of heat which is accurately obtained from the steam table, so that means are provided for computing the heat units given off. As this must all have been used in warming the air through a temperature T′—T, we have means of computing the weight of air: as the specific heat of air is 0.238, one heat unit would warm as many pounds of air 1° as 0.238 is contained in unity.

By comparing the velocity of the air as computed in this manner with the average reading of the anemometer, the error may be determined.

The errors of anemometers can also be obtained by direct comparison with instruments having known errors.

The velocity of air flowing through a duct of given size may also be determined by the use of large measuring tanks which are alternately filled and discharged with air in such a manner as to give accurately the volume of air flowing.

The Pitot Tube.—The Pitot tube for measuring air velocity is made by connecting a delicate manometer to a tube bent in such a manner that the opening can be made to face the current of flowing air. By comparing the readings of a manometer connected in this manner with a manometer connected so that the mouthpiece is at right angles to the current of flowing air, a difference in readings will be noticed, which is caused by the velocity of the flowing current. The reading of the Pitot tube in excess of the static pressure is produced by the velocity of air, and is proportional to h in the formula

$$v = k\sqrt{gh},$$

in which v is the velocity of the air in feet per second, and h is the head which is counterbalanced by the force causing the velocity, and may be measured in various units as inches of water, ounces of pressure, feet of water, etc.

If measured in inches of water, which is probably the most convenient measure, the theoretical value when $k = 1$ becomes

$$v = 46.8\sqrt{h}.$$

A series of experiments gave as a practical result

$$v = 70\sqrt{h},$$

corresponding to a value of $k = 1.47$ when air is at a temperature of 120°, $v = 66.7\sqrt{h}$, corresponding to a value of $k = \sqrt{2}$ when air is at a temperature of 60° F. For air at other temperatures this result must be multiplied by the following factors:

Temp. Air. Deg. F.	Factor.	Temp. Air. Deg. F.	Factor.
32	0.92	100	0.985
60	0.95	120	1.00
80	0.965	150	1.05

By connecting one side of the manometer to a Pitot tube and the other side to a plain tube the manometer may be made to show the difference of pressure due to the velocity of the air by a single reading and without subtraction.

The Pitot tube is well adapted for measuring high velocities of air and, with a sufficiently delicate manometer, it will give good results in measuring moderately low velocities. It is not, however, as well adapted for low velocities as the anemometer, nor can it be used as conveniently.

In 1884, the Prussian Mining Commission investigated, by means of a large gas-holder which contained over 70,000 cu. ft., various questions relating to the measurement of the velocity of air.

The results of this inquiry were briefly as follows: (1) that anemometers calibrated by swinging in still air show errors which range between 7 and 13%, the anemometers always reading high.

(2) A Pitot tube may be used with accuracy for measuring the velocity of air, the formula being as follows: velocity of air in meters per second at 0°C.

$$= 4.265\sqrt{\frac{\text{pressure in mm. head of water}}{\text{density of air}}}.$$

This reduced to the average temperature and density of the air becomes $4\sqrt{h}$, h being the head in millimeters of water.

(3) The fall in pressure between one side and the other of a thin orifice may be used. If H is the difference in pressure represented by feet of air, the formula for flow would be

$$Q = C A \sqrt{gH},$$

in which A is the area and C a coefficient which equals 0.64 for circular orifices and 0.61 for square orifices.

(4) The loss in head due to friction as obtained in a cast-iron pipe 14.3 ins. in diameter, was found to vary as the diameter of the pipe affected with the exponent 1.32, as the square of the velocity and as the density affected with the exponent ⅚.

The general results of the tests show that the anemometer gives an exaggerated value of the air discharged by a fan, especially when standardized by rotating in still air. In computing the volume of air delivered, the error in the result would be directly proportional to the error of the anemometer, which, as shown by the previous tests, averages not far from 10% high. The error in work performed and in efficiency, however, would vary as the cube of velocity and, consequently, as the cube of the error in the anemometer. If the anemometer error be 10%, the error in work done and in efficiency would be 33%.

The Work of the Fan.—The work performed by the fan is made up of the resistance due to moving and compressing a definite amount of air. It can all be considered as equivalent to moving a given weight of air through a height or head which is equivalent to the sum of the velocity and pressure heads expressed in feet of air at the density corresponding to the air after being compressed. These results can be expressed in the shape of a formula. Thus let Q equal the volume of the air at atmospheric pressure, Q′ its volume at delivery pressure, c the weight per cu. ft. at atmospheric pressure, c′ the weight at delivery pressure, W weight of air delivered per second, d density at atmospheric pressure, and d′ at the delivery pressure, v the velocity, A area of cross-section at point of measurement of velocity, and M work in foot pounds per second; then we shall have

$$Q = v A = Q\frac{d}{d'} A;$$

$$W = Q' c' = Q\frac{d}{d'} c\frac{d'}{d} = Q c,$$

$$M = \text{work} = Wh' = Wh\frac{d}{d'} = Qch\frac{d}{d'};$$

in which h equals the sum of pressure head and velocity head as measured at the same point expressed in feet of air at atmospheric pressure, and h′ the same quantity expressed in feet of air at delivery pressure.

In the testing of the fan it will be found that the pressure head, as measured from the manometer will be smallest, as a usual thing, when the velocity head, as measured from a Pitot tube, is highest, and conversely. Hence it is essential to measure these two quantities at the same point.

In case the velocity head cannot be directly measured by use of a Pitot tube, but instead of that the velocity is measured, the corresponding velocity head may be computed from the formula

$$h = \frac{V^2}{2g},$$

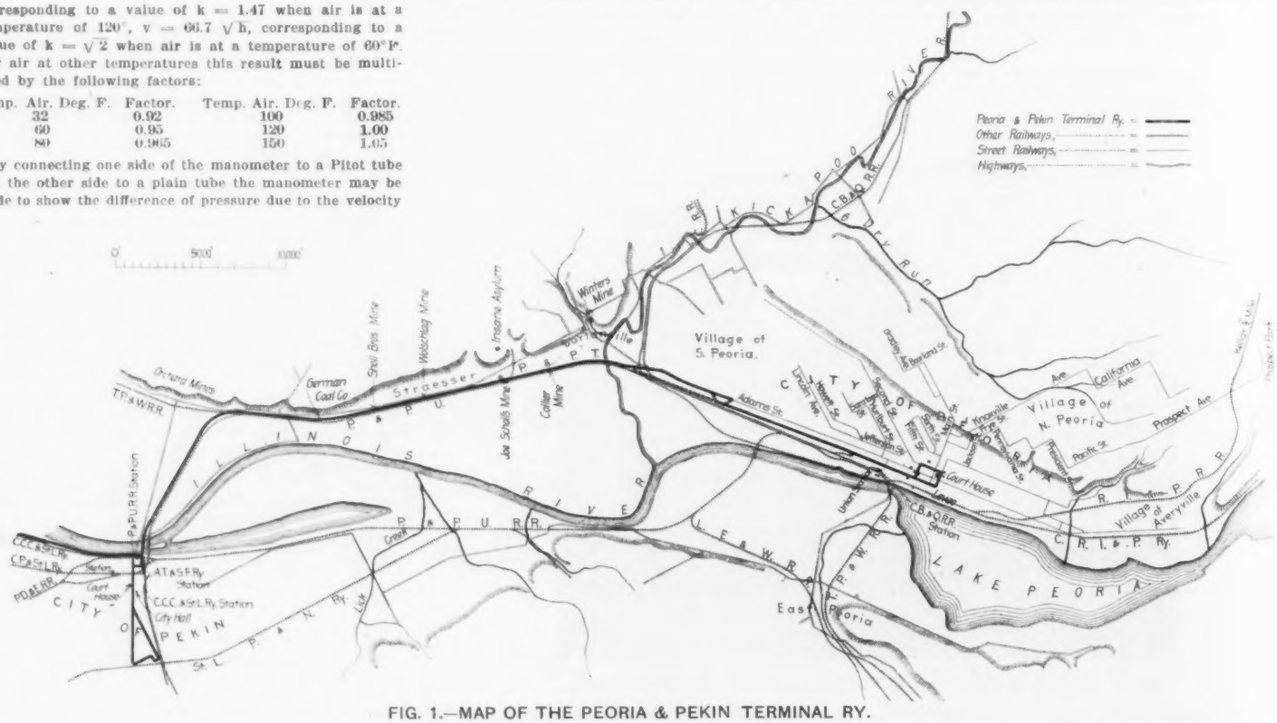
which is quite accurate for air of 60° temperature, but would be subject to correction for other temperatures, which may be deduced from the table previously given.

Notes Regarding Testing of Fans.—It will be found in the actual operation of testing fans that the air delivered moves in irregular currents, and, consequently, in order to obtain average results, readings must be taken in all portions of a given cross section. In order to obtain the average readings, the cross section should be subdivided into a number of small sections of equal area, and the velocity in each one of these smaller subdivisions should be obtained by the method described. In case the subdivisions are not of equal area, an allowance should be made in determining the average for those subdivisions which are larger, by multiplying the readings by factors giving the relative proportion of area.

As a rule the pressure and velocity readings of the fan should only be taken after the air has traveled some distance, in order that the inequalities spoken of may be lessened as much as possible. The use of baffle-plates to equalize the velocities and pressures is likely to add considerable friction head to the fan, and are not recommended.

Many of the tests which have been recorded of fans show an abnormal and sometimes an impossible efficiency. This is usually due to errors in the anemometer used, which make practically about three times as much difference in the efficiency as in the volume of air delivered, due to the fact that the error in volume would vary as the error of the anemometer, whereas the error in efficiency and in work performed would vary as the cube of this error.

There are certain losses which necessarily take place in the fan when constructed in the most perfect form, which are due to the striking of the particles of air against the vanes, to adverse air currents at the point of discharge from the vanes, and to friction against the casing. It is considered by some authorities that the unavoidable losses will reach from 25 to 33% of the power supplied the fan, and hence the limit of possible fan construction will result in an efficiency of from 66 to 75%. The efficiency of a fan varies with the pressure against which it works, the highest efficiency being usually found in our experiments when the fan is working under a back pres-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ILLINOIS RIVER
LAKE PEORIA
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Winters Mine
Joe Schell Mine
Collier Mine
German Coal Co.
Shell Bros. Mine
Hitchcock Mine
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of approximately 1 oz. Working under the condition of highest efficiency, the fan discharges the greatest volume of air per horse-power, but not necessarily the greatest volume, unless the volume be measured at atmospheric pressure.

It will also be found that the form of the fan blades has considerable effect on the results. In my experiments with different forms of blades at a given speed, the highest pressures have resulted when the fan blades were bent forward and the highest efficiency when the fan blades were bent backward.

The general results of my experiments would indicate that a fan efficiency of from 40 to 50% is as high as can be expected with the best construction working under favorable conditions, and, furthermore, that any published efficiency which is greater than 50% is to be regarded with considerable suspicion.

THE PEORIA & PEKIN TERMINAL RY.

This new railway, which is just approaching completion, has been built to form a connection between the several railways centering at the two cities of Peoria and Pekin, in Illinois (the distance between which is about ten miles), and also to provide a passenger service between the two cities. An interesting feature of the line is that while the freight traffic will be operated by steam locomotives, the passenger traffic will be accommodated by electric cars, running at high speed, and taking current from an overhead wire. There are eight railways at the Peoria end of the line: Chicago & Alton R. R., Chicago, Burlington & Quincy R. R., Chicago, Rock Island & Pacific Ry., Iowa Central R. R., Lake Erie & Western R. R., Rock Island & Peoria R. R., Toledo, Peoria & Western R. R., and the Vandalia Line. At Pekin there are five roads: Atchison, Topeka & Santa Fe Ry., Chicago, Peoria & St. Louis Ry., Cleveland, Cincinnati, Chicago & St. Louis Ry., Peoria, Decatur & Evansville R. R., and St. Louis, Peoria & Northern Ry. (the Pekin end of which has recently been absorbed by the Chicago & Alton R. R.). Fig. 1 is a map of the line.

The policy of the company has been to provide a roadway and bridges of substantial construction, together with an overhead system of more than ordinary strength and durability, in order to accommodate a heavy freight service and a high-speed electric car service. The passenger service extends from the Court House in Peoria, over the tracks of the local street railway to the city limits; thence onto the company's main line, by which it is to deliver the passengers at the Court House in Pekin, a distance of ten miles. The freight traffic will include the operation of the Peoria Terminal Co.'s yards under lease and unites their industrial tracks and connections with the various railways entering Pekin, using 8.3 miles of the P. & P. T. Ry. main line.

Leaving the city of Peoria, the line crosses Kickapoo Creek, then follows the contour of the foot of a bluff on the west side of the Illinois River, until opposite the city of Pekin. There it leaves the bluff and crosses the bottom land on an embankment 9 ft. high and 1.7 miles long. The Illinois River is then crossed on a bridge of four spans of 156 ft. and a 376-ft. draw span, the line continuing to its station grounds in the center of Pekin. The passenger station at Pekin will be neat and substantial, and, with the freight station, will cost $20,000. The power house is located midway between the two cities, and a car barn, round house and turntable have been built there also.

The roadbed is 14 ft. wide on embankments and 20 ft. in cuts. The track is laid with 70-lb. rails, 60 ft. long, rolled to the Am. Soc. C. E. section, and spliced with six-bolt angle bars. The ties are 6×8 ins., 8 ft. long, spaced 2 ft. c. to c. All sidings entering the main line have No. 8 spring-rail frogs. Crossings are constructed with easer rails throughout. The curvature outside the city limits is light, having only one curve exceeding 2°, while within the city limits the passenger cars necessitate curves of not less than 80 ft. radius. The grades are light, having short reaches of 0.75%. The earthwork averaged about 20,000 cu. yds. per mile.

A concrete pier and abutment, Fig. 2, carry the 156-ft. span across Kickapoo Creek. Six piers and an abutment of first-class stone masonry have been built to carry the Illinois River bridge. For this latter bridge, the river bed was dredged to a

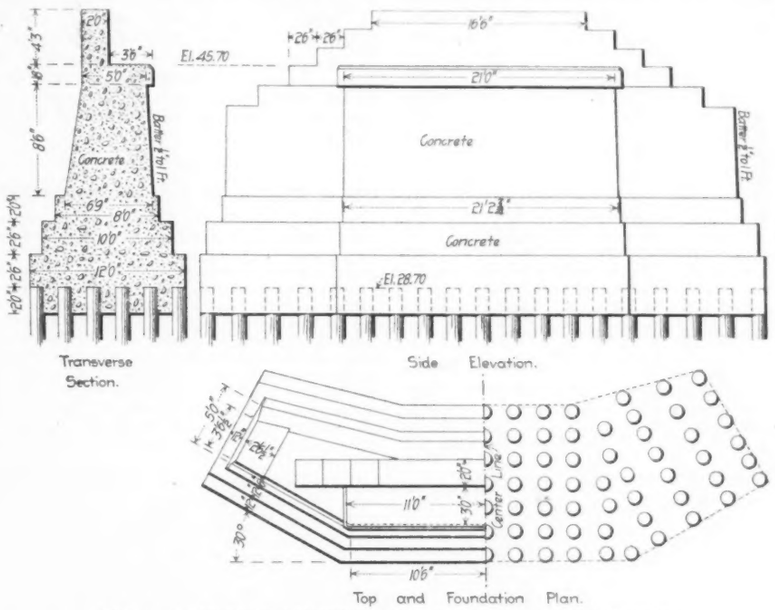


FIG. 2.—CONCRETE ABUTMENT FOR KICKAPOO CREEK BRIDGE.

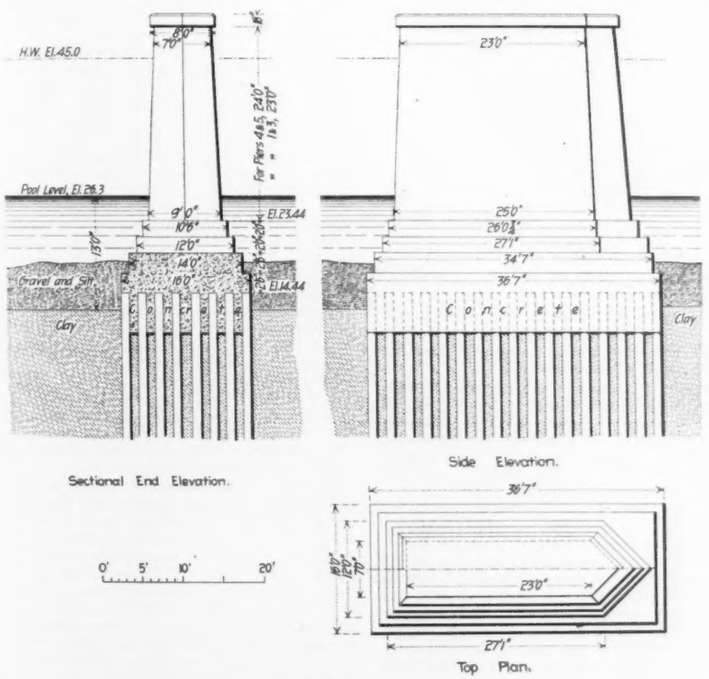


FIG. 3.—PIERS FOR FIXED SPANS OF ILLINOIS RIVER BRIDGE; PEORIA & PEKIN TERMINAL RY.

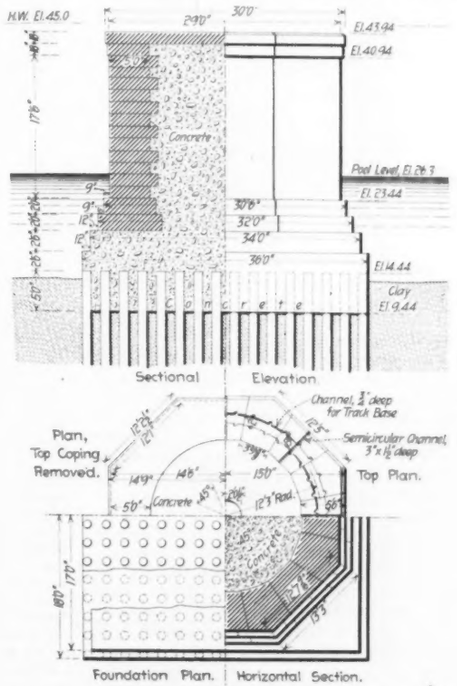


Fig. 4.—Pivot Pier of Illinois River Bridge; Peoria & Pekin Terminal Ry.

depth of about 7 ft. and foundation piles driven. Wakefield sheet piling was then driven around the main piling and the water pumped out, the excavations deepened and piles sawed off by hand. Footings of Portland cement concrete enclosed the heads of the piles and served to start the masonry. The drawings of the pivot pier and the piers for the fixed spans are given in Figs. 3 and 4, while Fig. 5 shows views of the piers. The steel bridge is designed to carry a dead load of 2,250 lbs. per ft., and a live load of 4,700 lbs. per ft. The draw span will be operated by electricity, power being furnished direct from the company's line. The bridge is midway between a highway bridge and the bridge of the Peoria & Pekin Union Ry.

Two Buckeye engines of 400-HP. capacity at medium speed, belted to two General Electric 225-K-W. generators, have been installed in the power house, together with a switchboard having all modern appliances, including wattmeter and clock. There are three Babcock & Wilcox water-tube boilers of 250 HP. each. The power house and grounds are lighted by arc lamps, current being taken from a two-phase alternator located there.

The poles for the trolley wire are spaced 100 ft. apart, set 7 ft. in ground with a tie at toe and heel. Brackets 9 ft. long hold trolley wire 21 ft. 6 ins. above the track. The feeder is of bare copper, stranded, 600,000 circular mills, connected with the trolley by No. 10 feeder tap at every tenth pole. The line is divided in the middle by a section insulator, and there are no overhead switches.

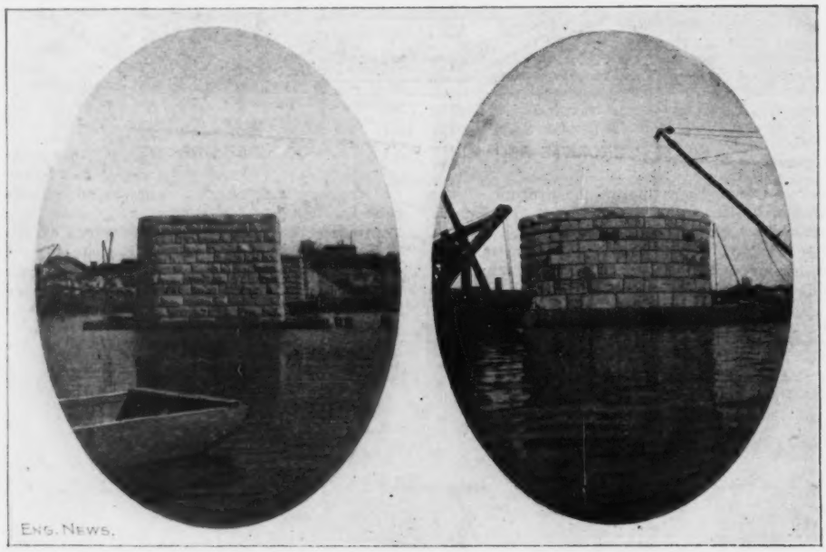
It is intended to run electric trains every half hour between Peoria and Pekin, convenient sidings being provided to enable freight trains to run without interfering with the electric railway schedule. The electric trains will be made up of two cars each, the motor car being a combination baggage, smoking and passenger car.

The passenger equipment consists of ten cars, each 41 ft. 6 ins. long and 8 ft. wide, built by the American Car Co., of St. Louis, Mo. The motor cars will seat 40 passengers, and the trailers 48. The equipment of the motor cars consists of four General Electric, 1,000 motors, giving a capacity of 125 HP., and they are fitted with air brakes, provision being also made for the use of air brakes on the trailers. The cars are heated by electric heaters, and automatic circuit brakes are substituted for the generally used overhead switches. The platforms have safety gates controlled by the motorman only. Cars are operated from one end, using track loops at each end of the line. The front end of each motor car is fitted with a pilot and headlight. A telephone line has been constructed the full length of the road with provision for connection at every fifth pole. Each car carries a complete telephone outfit.

The freight equipment consists of three 60-ton Rogers switching engines and 50 gondola cars of 40 tons capacity.

The amount of traffic is as yet, of course, uncertain, but in the judgment of the persons interested it will probably necessitate a second track in the near future.

The President of the Peoria & Pekin Terminal Ry. is Mr. T. J. Miller, of Peoria, Ill., and Mr. L. E. Myers, of Chicago, is General Manager. Mr. N. D. Monsarrat is Chief Engineer, and Mr. N. C. Draper, Mechanical Engineer. We are indebted to Mr. Monsarrat for the above information respecting the line. Mr. M. H. Hubbell is Superintendent.



Pier for Fixed Span. Pier for Draw Span.

FIG. 5.—PIERS OF ILLINOIS RIVER BRIDGE; P. & P. T. RY.

ANNUAL MEETING OF THE INDIANA ENGINEERING SOCIETY.

The 20th annual meeting was held at Lafayette, Ind., Feb. 1 to 3, the headquarters being at the Lahr Hotel, and the meeting being held in the Engineering Building of Purdue University.

The first session was called to order about 2 p. m. on Feb. 1, the president, Mr. A. J. Hammond, of Terre Haute, Ind., being in the chair. In the absence of Mr. Smart, the President of Purdue University, the address of welcome was delivered by Prof. W. F. M. Goss, who referred to the aims and scope of work of the university, and to the relations between technical education, laboratory research and professional work. Mr. Hammond made a few remarks in reply to the address, and the minutes of the last meeting were then read. The report of the secretary, Mr. J. B. Nelson, of Indianapolis, showed that the society now has 50 members. This was followed by the annual address of the president.

The first paper presented was one on "Local Street Improvements; Methods and Results," by Mr. W. K. Eldridge, City Engineer of Lafayette. This paper described the various stages of street paving development in that city, showing, among other things, that Portland cement is now being used instead of natural cement for foundations for paving. The latter concrete is apt to give way over soft places, such as old trenches, etc., while the former will bridge over such places. The discussion turned partly on this question and partly on the deterioration of asphalt when carted a long distance from the works to the place where the paving is being laid. Brick paving, however, received the most attention, and it was shown that there is diversity of opinion as to whether the bricks should be laid diagonally or at right angles across the street. Prof. Hatt also made some remarks on the three systems of rattler tests for brick: (1) The Jones test, with brick fixed in the rattler; (2) the Talbot system, with brick and cast-iron "shot" mixed; (3) the National Brickmakers' Association standard test, with bricks alone and no "shot." Prof. Severance Burrage then gave an interesting talk on biological work connected with sanitary engineering, in which he described the methods of taking samples of water, preparing the cultures, etc.

In the evening, Prof. D. B. Luten read a paper on "Paving Brick and Brick Pavements," illustrated by stereopticon views of pavements, rattlers, diagrams of tests, etc. The general opinion among the members seemed to be that it is difficult to make comparisons or to draw practical conclusions from the results of tests of the quality of brick. After the paper had been presented the party adjourned to the university library, to attend a reception held by the professors and officers, which the mandolin club and glee club furnished a musical entertainment.

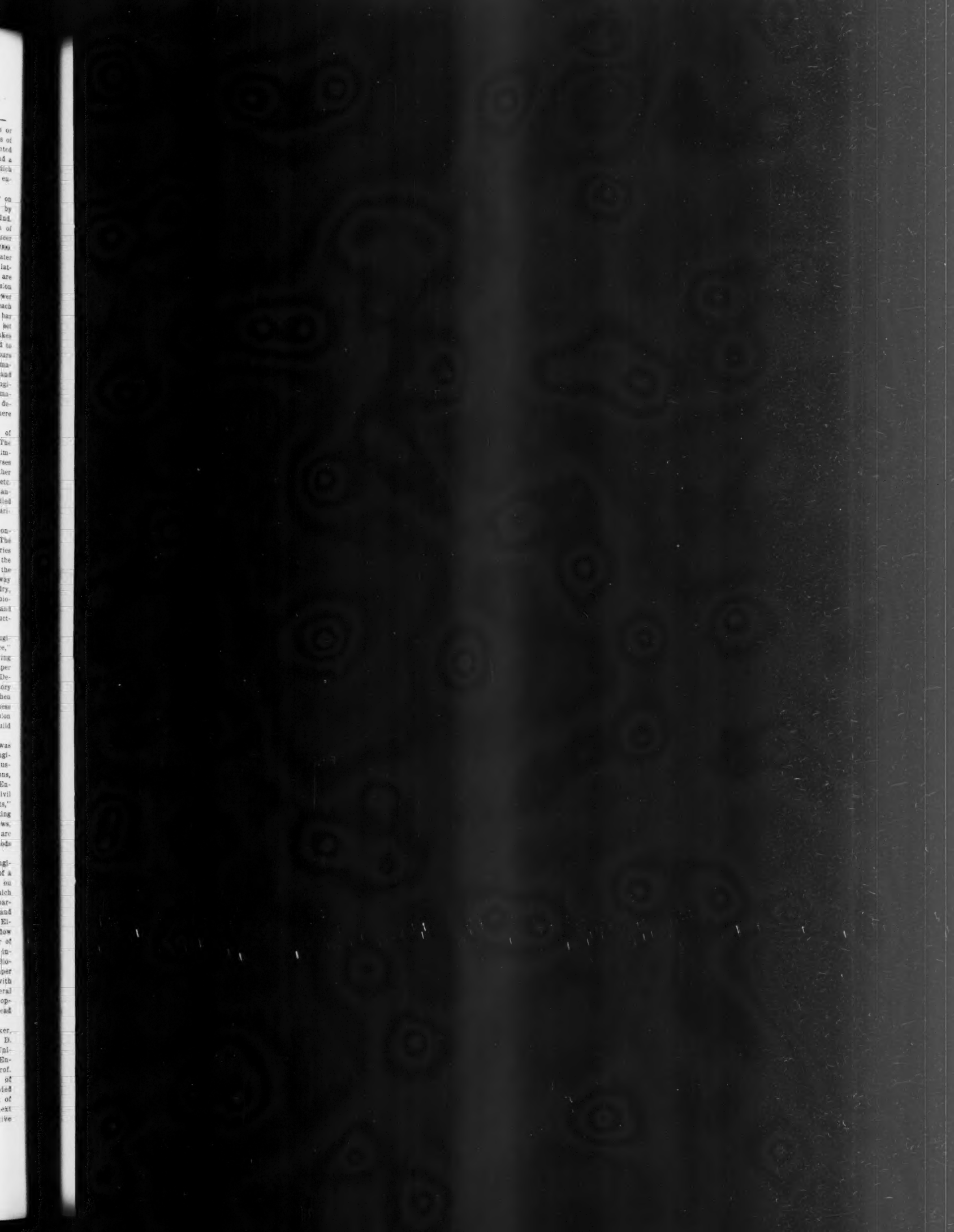
At the meeting on Friday morning, Feb. 2, a paper on "The Practical Side of Civil Engineering" was read by Mr. A. W. Smith, formerly City Engineer of Kokomo, Ind. This was followed by one on "The Sewerage System of Greenfield, Ind.," by Mr. Will J. Cleary, City Engineer of that town, which has a population of about 5,000. The sewers are for house drainage only, as surface water is discharged into natural water courses, and house laterals are built to the property line at the time sewers are built. This paper brought out an interesting discussion as to different methods of setting stakes for sewer trenches. Mr. Guthrie stated that he puts stakes on each side of the trench, at intervals of 25 ft., with a grade bar clamped to them by special clamps. Line stakes are set at 100-ft. intervals. At Grand Rapids the grade stakes are set on one side only, the contractor being required to put them on the other side, and to put up the grade bars with a spirit level. The question of trenching by machine instead of by hand labor was also brought up, and Mr. E. E. Russell Tratman, Associate Editor of Engineering News, described some different forms of machines for this purpose. Mr. A. J. Hammond also described some work done by one of these machines where the trench was as much as 30 ft. deep.

Mr. W. E. Stone, Vice-President and Professor of Chemistry, then gave an interesting address on "The Chemist and the Engineer," in which he outlined the important part played by the chemist in regard to analyses and tests of steel, wood, cement, asphalt, and other structural materials, as well as of water, sewage, etc. Mr. W. K. Hatt, Associate Professor of Applied Mechanics, then presented a paper on "The Strength of Nailed Joints," describing tests made with joints nailed in various ways and with different kinds of nails.

Lunch was served in the Woman's Hall, and at its conclusion there were a number of informal speeches. The afternoon was spent in visiting the various laboratories and shops of the engineering department, including the locomotive, air-brake, and brakeshoe-testing plants, the apparatus for determining the air resistance of railway trains, the machine and woodworking shops, foundry, forge, hydraulic and electrical laboratories, and the biological laboratory. During this trip, explanations and demonstrations were made by the professors and instructors in charge of the several departments.

At the evening meeting, Mr. J. W. Fawcett, City Engineer of Delphi, read a paper on "Problems in Practice," describing some problems met with in land surveying work. Mr. J. S. Spiker, of Vincennes, then read a paper entitled "A Public Highway Marks the Progress and Degree of Civilization," in which he first traced the history of roads from the days of the Roman empire, and then discussed the importance of good country roads in these present days. This paper brought out some discussion on the problems involved in getting authority to build roads and in building and maintaining them.

A short paper on "The New East River Bridge" was then read by Mr. G. E. Waesch, Instructor in Civil Engineering, of the University Staff, the paper being illustrated by lantern views of the drawings of the caissons, towers, etc., reproduced from drawings published in Engineering News. Prof. W. D. Pence, Professor of Civil Engineering, then read a paper on "Standpipe Accidents," illustrated by a number of lantern slides. The meeting concluded with some remarks by Prof. C. P. Matthews, of the Electrical Department, on the subject of arc lighting, illustrating the arc, and showing the methods of photometric measurement.

On Saturday, Feb. 3, Mr. John Finan, Jr., City Engineer of Elwood, read a paper on "The Responsibility of a City Civil Engineer." This was followed by a paper on "Tile Drainage," by Mr. L. S. Alter, of Remington, which brought out some discussion, this being a subject of particular interest to engineers in Indiana, where much land has been improved and reclaimed by drainage. Mr. Eldridge questioned the utility of tables of capacity of flow of tile, as they do not take into account the character of soil, slope of land, and other matters which have an influence on the flow. Mr. Severance Burrage, of the Biological Department of the University, then read a paper on "Odors and Tastes of Drinking Water," dealing with micro-organisms and not with the influence of mineral or vegetable matter. A paper on "Water Power Development," by Mr. T. R. Christian, of Indianapolis, was read by title.

Officers were elected as follows: President, J. S. Spiker, City Engineer of Vincennes, Ind.; Vice-President, W. D. Pence, Professor of Civil Engineering at Purdue University, Lafayette, Ind.; Secretary, W. J. Cleary, City Engineer of Greenfield, Ind. Executive Committee—Prof. W. F. M. Goss, of Purdue University; J. B. Nelson, of Indianapolis, and A. W. Smith, of Kokomo. It was voted that the appointment of committees, the arrangement of program, and the selection of the place for the next meeting should be put in the hands of the Executive Committee. The society then adjourned.